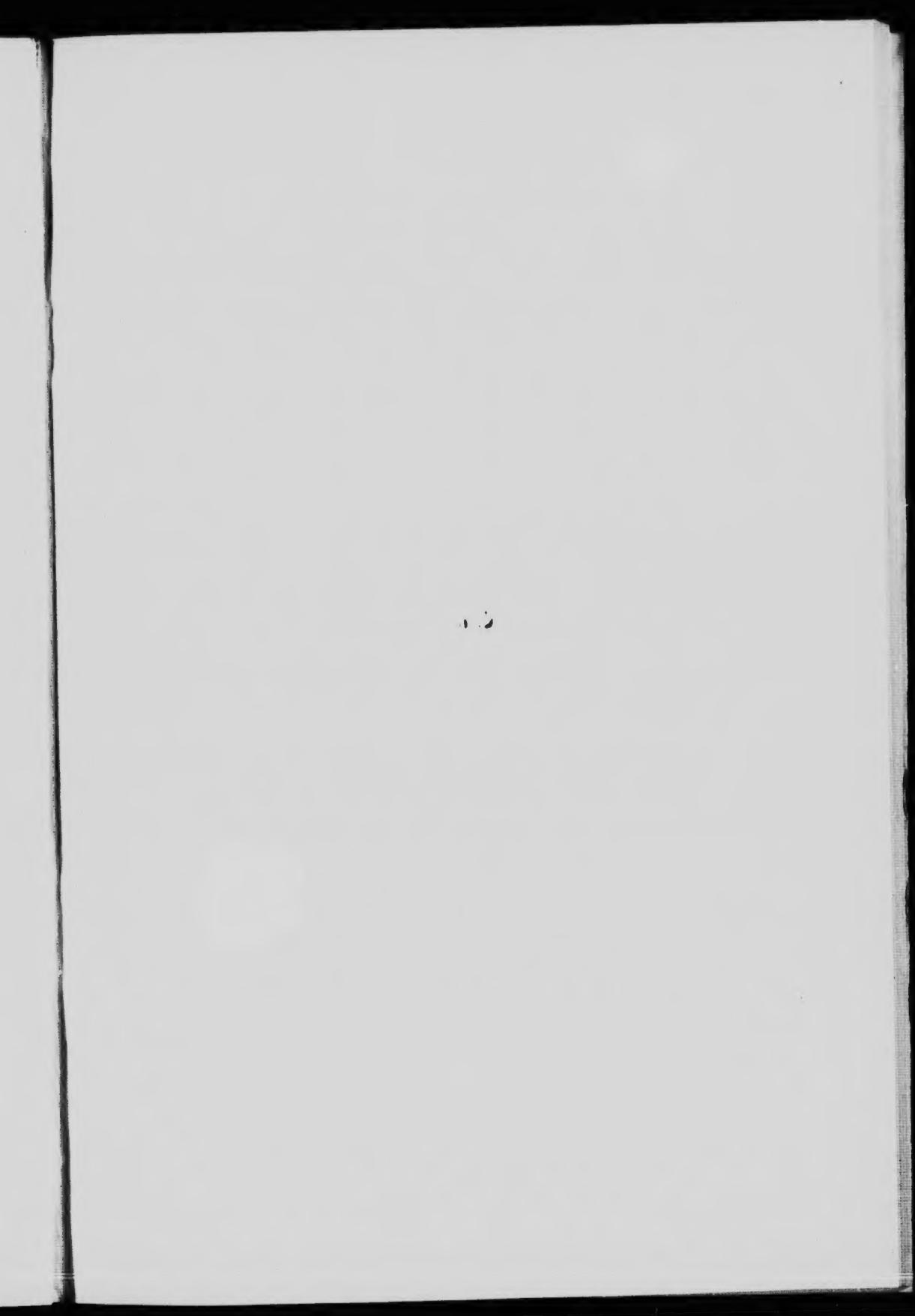


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CANADA
DEPARTMENT OF MINES
HON. ARTHUR MEIGHEN, MINISTER; R. G. McCONNELL, DEPUTY MINISTER
MINES BRANCH
EUGENE HAANEL, Ph.D., DIRECTOR.

BULLETIN No. 32

**Report on Road Materials along the
St. Lawrence River, from the
Quebec Boundary Line to
Cardinal, Ontario**

BY
R. H. Picher.



OTTAWA
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LETTER OF TRANSMITTAL.

DR. EUGENE HAANEL,
Director Mines Branch,
Department of Mines,
Ottawa.

Sir,—I beg to submit, herewith, a report, with maps, on the Road Materials along the St. Lawrence River from the Quebec boundary to Cardinal, Ont. This report has been prepared by Mr. R. H. Picher of the Road Materials Division.

I have the honour to be, Sir,
Your obedient servant,

(Signed) **K. A. Clark,**
Chief, Road Materials Division.

Ottawa,
Jan. 9, 1920.

ПОМАРІ
ВЛАДИМІР

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ROAD MATERIALS ALONG THE ST. LAWRENCE RIVER, FROM THE QUEBEC BOUNDARY LINE TO CARDINAL, ONTARIO.

INTRODUCTORY.

A road materials survey was made during the summer of 1917 over a strip of country 4 to 5 miles in width, along the St. Lawrence river, from the Quebec boundary line to Cardinal, Ontario. This area extends over a distance of 59 miles, and includes parts of Glengarry, Stormont, Dundas, and Grenville counties. The survey was undertaken in order to secure information regarding available road making materials, with a view to facilitating the planning of the proposed improved highway between Montreal and Toronto. The route of this highway will, presumably, follow the bank of the river.

The writer was assisted in his task by L. Clermont and E. Giguère, who performed their work in a thoroughly satisfactory manner.

GENERAL CHARACTER OF THE COUNTRY.

TOPOGRAPHY.

The country extending along the St. Lawrence river, between the border line of Quebec province, and Cardinal, Ont., and at right angle therefrom northward for 5 miles, is best described as a rather flat plain, sloping southeastwards to that river. Between Cornwall and Lancaster a characteristic feature is the occurrence of a series of ridges trending in a direction parallel to the St. Lawrence river. West of Cornwall, and as far as Aultsville, broad, low hills are commonly seen. Many of these hills have long, narrow ridges, running approximately north-south, bordering their western edge. At their south end the ridges rise a few feet over the hill with rather sharp western slope; but towards their north end they become gradually lower, and are not clearly distinct from the rest of the hill. Between Aultsville and Cardinal the same hills and ridges are found in smaller number, and rise only a few feet above the plain.

East of Cornwall, the plain lies only a few feet above the level of the St. Lawrence. It rises northward at a very low rate. The parallel ridges between Cornwall and Lancaster have elevations of from 25 to 50 feet above the flat. West of Cornwall the main flat is from 15 to 25 feet above the water-level of the St. Lawrence. The hills and ridges between Cardinal and Cornwall rise at elevations of from 5 to 30 feet above the plain, the highest being near Cornwall. The divide between the Ottawa and St. Lawrence River basins comes into the 5-mile belt north of Morrisburg; and near Cardinal it is only 2 miles from the shore of the St. Lawrence. At this point the northern side of the divide has a slope of only a few feet per mile, while the southern side slopes at a rate of about 25 feet per mile. The many small creeks emptying into the St. Lawrence river form gullies along the shore, these being particularly common between Cornwall and Morrisburg.

The Raisin river is the only important stream draining the country. It rises only a few miles from the St. Lawrence river, runs nearly parallel to it for over 20 miles, and empties into the main river at Lancaster, 9 miles west of the eastern border of Ontario. It flows through a flat channel, with an average fall of 3 feet per mile. The water-level of the St. Lawrence river above Cardinal and of Lake St. Francis near the Quebec line, is 242 feet and 153 feet, respectively, above sea-level. Many stretches of land, especially in the depressions between ridges, are marshy, and have remained uncleared.

GEOLOGY.

The rock outcrops consist of Beekmantown dolomites and Black River and Chazy limestones: all of the Palæozoic era. Dolomites of the Beekmantown are seen exposed at several places around Cardinal. The stone is generally dark grey in colour, and medium to fine-grained. All the outcrops are of rather small extent, and in nearly every case they lie in the north slope of flat hills 4 to 15 feet in height. The highest hill is found 1½ miles west of Cardinal, where a large excavation has exposed a section 23 feet in height above underground water-level. Exposures of Black River limestone occur at different points north and west of Cornwall. Only two are of real importance, one 4 miles north, and the other 5½ miles west, of that town. The stone is very dense, almost black in colour, and presents the same character in nearly every case. The stone occurrences lie in low places; and west of Cornwall most of it is covered with from 2 to 10 feet of drift, except where exposed by quarrying. One mile southeast of Summerstown station, limestone of the Chazy formation lies close to the surface, covering an area of about 2 acres. The rock is exposed in an old quarry, to a depth of 2 feet, but does not outcrop on the surface. The stone is light grey in colour, and of medium even grain.

The beds of the dolomites and limestones dip at very low angles with the horizon. The Beekmantown dolomites are thin-bedded, and Black River limestones thick-bedded, with many pencil-line partings. The joints are approximately at right angles to the bedding plane, but show no regularity in other ways.

Glacial striae were observed north and west of Cornwall, with direction varying from N. 12° W. to N. 20° W. Other striae, less commonly seen, had directions of N. 10° E., N. 18° E., and N. 55° W.

A large part of the country west of Cornwall is covered with boulder clay. To the east, the boulder clay is found more often on the higher lands, lying in the form of small ridges and hills. As seen from a few shallow sections, it is most frequently composed of rounded boulders and angular pebbles in a light bluish-grey matrix of fine sand, silt and some clay. The pebbles are largely limestone. The proportion of clay in the matrix seems to be higher west of Morrisburg than to the east. The most important gravel deposits lie in Cornwall and Osnabruck townships. Outside of this area they are of less frequent occurrence. Between Cornwall and the Quebec border, the gravels lie in flat ridges on top of the boulder clay without any distinct outline between the two. West of Cornwall, most of them form small, well-marked ridges lying on the western slope of large boulder clay hills. They are in most places very bouldery on top, becoming finer and more markedly stratified below. The deposits contain marine shells, occurring in aggregations and layers in the boulders and

gravel to depths of 13 feet from the surface. The occurrence of collections of unbroken, fragile shells, in and under thick bouldery deposits, is of geological interest. Stratified blue marine clay occupies most of the country north and east of Cornwall. Much smaller strips of marine clay are seen west of Cornwall, and close to the river. A narrow belt of sand lies along the shore of the St. Lawrence river for 16 miles, from Cornwall west to Aultsville.

ROAD CONDITIONS.

The St. Lawrence River road is the most important line of travel through the area under consideration. It will probably be made part of the Montreal-Toronto trunk road. Most of the through traffic goes over it. This is not heavy at present, due to the bad condition of the road. Other lines run at right angles to this road from the principal towns along the river. Of these the Cornwall, Morrisburg, and Lancaster roads carry the heaviest traffic. The road from Lancaster northward, leads to Alexandria. The Morrisburg road goes through Winchester and Metcalfe, connecting with the Metcalfe road to Ottawa. The road from Cornwall connects northward with the old King's road, which was the first opened by the early settlers in this part of the Province, and remained for a long time the main line of travel. The local traffic on the Morrisburg and Cornwall roads is nearly equivalent to that over the front road. The old King's road, although more extensively used than farm roads, is subjected to a light traffic.

Grades on the St. Lawrence road are flat, except from Mille Roches west to Cardinal, where many steep-sided gullies formed by streams flowing into the St. Lawrence are crossed. The Lancaster and Morrisburg roads run through perfectly level land. The country traversed by the Cornwall and the King's roads is slightly rolling, with long gentle grades.

Sections of the St. Lawrence road have been gravelled or macadamized at different times. As a whole, it is in bad condition, although the surface, for the most part, is still firm. This will undoubtedly help out in building a foundation for a new road. The soil along the front road consists of blue marine clay in the east part of the surveyed area, and boulder clay in the west part. A belt of sand stretches from Cornwall to Aultsville, but it is very thin towards the west, and only partly covers the underlying clay. Small isolated areas of sand are encountered between Morrisburg and Cardinal. In the high parts of the road in Charlottenburg township, the soil is largely made up of sand and boulders.

During the spring, the River road, where the swamps of Lancaster and eastern Charlottenburg townships are crossed, is said to be in very bad condition. Near the western border of the latter township, and in some of the gullies between Aultsville and Morrisburg, the stoned surface is completely gone, exposing the clay subsoil, which in wet weather is cut into deep ruts. East of Mille Roches, a section of road through heavy sand has given much trouble. The stoned surface on the Cornwall and Morrisburg roads is in good condition, except for one-half mile through a swamp north of Morrisburg. This section is cut by as many as 10 longitudinal ruts in the width of the travelled way. The Lancaster and King's roads have, at different times, been partly gravelled but are now hardly any more than good earth roads. The former is said to be badly drained in the spring.

ROAD MATERIALS

Bedrock, field stone, and gravel, are the only available road materials. Rock exposures are of small extent, and occur only in a few places. Boulder deposits, or field stone and gravel deposits, are most common between Cornwall and Aultsville, but everywhere else they are found only in isolated patches. From the Quebec border west, nearly as far as Lancaster, boulders and gravel are of very rare occurrence. The bedrock is probably the best road material, although the field stone in certain localities is nearly equivalent to it in durability. The proportion of durable material in the boulder deposits of field stone increases regularly from the east to the west end of the area. The boulder deposits are, with a few exceptions, of better quality than the gravel deposits of the same locality. The best gravels occur in Cornwall and Osnabruck townships. The bedrock, most of the field stone, and several gravel deposits, are suitable materials for broken stone or gravel roads under ordinary country traffic conditions, but none of them would be sufficiently durable to be used on roads subjected to fairly heavy traffic.

BEDROCK

Twenty-five outerop areas were mapped within the district surveyed; all of which were of small extent. Nine outerops of Beekmantown dolomite occur around Cardinal, and west of Iroquois. Eleven exposures of Black River limestone are seen in two localities west and north of Cornwall respectively. Two small areas, one of Black River and the other of Chazy limestone, lie in the west end of Charlottenburg township. Southeast of Summerstown station, there is a small quarry of Chazy limestone.

Laboratory Tests.

Tests have been made on three samples of Beekmantown dolomite occurring north and west of Cardinal, and on four samples of Black River limestone exposed north and west of Cornwall; see Table II, page 6.

Recent standard recommendations on the per cent of wear and toughness of stone used in road surfaces are given in the following table^a:

TABLE I.
Limiting values of percentage of wear and toughness under varying traffic conditions.

Type of road surface.	Light traffic, up to about 100 vehicles per day.		Moderate traffic, 100 to 200 vehicles per day.		Heavy traffic, 250 vehicles per day and over.	
	Wear, per cent.	Toughness.	Wear, per cent.	Toughness.	Wear, per cent.	Toughness.
Water-bound macadam.....						
a.	5 to 8	5 to 9	2.7 to 5	10 to 18	0 to 2.7	over 18.
b.	5.7-	6+				
c.	5-	6+				
Bituminous broken stone with seal coat and broken stone with bitu- minous carpet.....						
a.	8-	5+	5.7-	10+	5.7-	10+
b.						
c.						
Bituminous concrete with or without seal coat.....						
a.	5.7-	7+	4-	13+	4-	13+
b.	3.5-	13+	3.5-	13+	3.5-	13+
c.	3.5-	13+	3.5-	13+	3.5-	13+

^a Recommended by the Office of Public Roads, Washington, 1916.

^b Recommended by the American Society of Municipal Improvements, 1914.

^c Recommended by the American Society of Civil Engineers, 1917.

+= "and over," that is, the figure is a minimum value.

- = "and under," that is, the figure is a maximum value.

According to aforementioned requirements, two of the seven samples tested, Nos. 17 and 22, are of sufficient durability for heavy traffic, if used on the road surface in connexion with a bituminous carpet, while the remaining five samples tested are only suitable for use in waterbound macadam roads subjected to light traffic.

TABLE II.
Results of Tests upon Bedrock.

Map No.	Location.	Rock Species.	Formation	Percent age of wear.	French coefficient of wear.	Toughness.	Hardness.	Specific gravity	Water absorbed per cubic foot.	Remarks
7	4 miles north of Cornwall	Limestone	Black River	3.5	11.4	6	16.6	2.71	0.27	
7a	4 miles north of Cornwall	Limestone	"	3.3	12.1	8	16.0	2.71	0.16	
10	5 miles west of Cornwall	Limestone	"	3.2	12.5	5	16.4	2.71	0.36	
13	5 miles west of Cornwall	Limestone	"	3.5	11.4	.....	.....	2.71	0.17	Sample taken from damp pit.
15	1 mile southwest of Troisois	Dolomite	Berkman- town	2.7	11.6	10	16.5	2.82	0.97	Duplicate sample.
22	3 miles north of Cardinal	Dolomite	"	3.2	12.5	11	16.3	2.83	0.96	Duplicate sample.
25	14 miles west of Cardinal	Dolomite	"	2.9	13.8	5	15.6	2.82	0.7	Toughness piece coarser than average in quarry.

Service Tests.

In only one instance has bedrock been used for road surfacing: at the time the Galop canal was dug—15 to 20 years ago—the canal road between Iroquois and rock outcrop No. 18 was surfaced with broken stone blasted out of the canal channel. No repair work has ever been done. When seen in the fall of 1917, it was worn out. As many as 12 longitudinal ruts, varying in depth from 1 to 3 inches, had been worn in the width of the travelled way. No deductions as to the quality of the stone can, of course, be drawn from this case.

Availability.

Exposures of Beckmantown dolomites occur in most cases on the north slope of low hills. The exposure west of Cardinal appears the most promising for future development. A large excavation has left exposed a 16-foot section of good stone above underground water-level, with from 1 to 4 feet of loamy silt and sand covering the rock. The overburden would probably be a serious obstacle to extensive quarrying, but several thousand cubic yards can be obtained without much stripping. The two dolomite exposures 3 miles north of Cardinal are covered, one by a few inches of boulder clay, and the other by from 4 to 12 inches of loam, except in the centre of the latter, where the thickness is unknown. Assuming that excavation is limited to thinly covered areas only, the two exposures should yield over 10,000 cubic yards of stone, taking $1\frac{1}{2}$ yards as the average depth of excavation. In case of deeper quarrying, the ground water would have to be taken into account. The hauling distance to the front road and canal from this place is not quite 3 miles. In outerops Nos. 20 and 21, the stone splits readily in thin layers. It could be quarried to a depth of 2 yards without trouble arising from underground water, and very little stripping would be required. The deposit lies along the road, and three-fourths of a mile from the front road and canal. In the case of No. 19, the overburden is such a serious factor that further quarrying is out of the question. Exposures Nos. 17 and 18 lie in a low place surrounded by swamp. Over 2,000 cubic yards could probably be obtained without excavating below water-level. Deposit No. 16 lies at the foot of a low hill, and is covered with dark brown loam, up to 2 feet in thickness. Quarrying deeper than 2 feet would be hampered by ground-water. An excavation of that depth would yield over 5,000 cubic yards. The deposit lies $1\frac{3}{4}$ miles from the front road and canal.

No. 10, west of Cornwall, is an exposure of Black River limestone lying near the foot of a hill, with from $\frac{1}{2}$ to 2 feet of bouldery loam on top of it. About 30,000 cubic yards could probably be obtained by quarrying to a depth of $1\frac{1}{2}$ yards. It is situated within a hauling distance of $1\frac{1}{2}$ miles of the front road, canal, and railway siding. Other exposures in the same locality lie in a swamp, with from 2 to 8 feet of loamy clay covering the rock. The rock does not outcrop, but has been exposed in large openings, now nearly filled with water. The overburden is too heavy for further quarrying. Over 20,000 cubic yards of waste stone have been dumped in several big piles near the quarries. The stone is largely under 1 foot in size. Rock outcrops Nos. 6, 7, and 7a, north of Cornwall, have been extensively quarried. Over 100,000 cubic yards could be obtained, with

average depth of excavation of 2 yards. The deposits lie at a hauling distance of $4\frac{1}{2}$ miles from the front road. Nos. 4, 5, and 8 are too small to be considered for future development; Nos. 2 and 3 are doubtful outcrops. The Chazy limestone, southeast of Summerstown station, is covered by drift varying in thickness from a few inches to 2 feet. A few thousand cubic yards could be taken out, quarrying at an average depth of 1 yard. The material would have to be hauled nearly 3 miles to reach the front road.

BOULDER DEPOSITS OR FIELD STONE.

While an inspection of rock outcrops and gravels was made on a 5-mile belt along the St. Lawrence river, boulder deposits were examined and mapped only as far as 2 miles from the river. The field stone is of most frequent occurrence between Lancaster and Aultsville, and farther west between Iroquois and Cardinal. From Aultsville west to Iroquois it lies only in small detached areas, and is especially scarce around Morrisburg, and from Lancaster east to the Quebec border. Table III gives the yardage and composition of the field stone for each township, beginning at the east end of the district examined. There are separate amounts for the stone under 1 foot, and for that over 1 foot in size. The composition is in percentage of "Durable," "Intermediate," and "Soft." "Durable" includes granites, gneisses, syenites, gabbros, anorthosites. "Intermediate" includes partly weathered stones of the above-named types, much foliated gneisses; fine-grained Potsdam sandstone; Beekmantown dolomite; Chazy, Black River, and Trenton limestone; and Chazy sandstone. "Soft" includes coarse-grained Potsdam sandstone; soft or shaly limestones; soft Chazy sandstone; and weathered stone of all kinds.

TABLE III.
Amount and Composition of Field Stone.

Township.	Number of Cubic Yards.			Composition.					
	Total.	Under 1 ft.		Under 1 ft.			Over 1 ft.		
		Under 1 ft.	Over 1 ft.	Durable	Inter.	Soft	Durable	Inter.	Soft
Lancaster.....	3,327	1,403	1,924	2	49	49	15	58	27
Charlottenburg.....	58,077	31,812	26,265	7	61	32	17	61	22
Cornwall.....	30,032	16,408	13,624	12	50	38	34	41	25
Osnabruck.....	19,610	11,716	7,894	22	49	29	51	35	14
Williamsburg.....	4,257	2,942	1,315	27	46	27	68	22	10
Matilda.....	14,092	6,726	7,344	37	41	22	77	14	9
Edwardsburg ¹	2,558	1,014	1,544	53	27	20	80	12	8

¹ Only a small part of this township was surveyed.

The proportion of stone under 1 foot in size varies for the different townships, from two-fifths to two-thirds of the total. The stone over 1 foot in size has everywhere a higher proportion of "Durable" than the smaller stone; and this proportion increases regularly for both sizes of stone, towards the west of the district. The types of stone classified as "Durable" are nearly the same all over the area, consisting mainly of gneisses, syenites and granites, with gabbros and anorthosites in smaller amounts. The constituents of "Intermediate" and "Soft" vary with the

localities the type representing the underlying rock generally predominating. In Lancaster township the stone is largely Chazy limestone and sandstone; classified as "Intermediate," and, where partly weathered, as "Soft." The same kinds are found in Charlottenburg, with Potsdam sandstone and Beekmantown dolomite in smaller quantities. The deposits of eastern Cornwall are made up of Potsdam and Chazy sandstone, and, to a lesser extent, of Black River and Chazy limestone, and Beekmantown dolomite; while in western Cornwall and all of Osnabruck, Potsdam sandstone and Black River limestone are the two predominant types. In Williamsburg township the most common kind is Black River limestone; with Potsdam sandstone, Trenton and Chazy limestones in about equal proportions. The deposits in Matilda and Edwardsburg townships consist largely of Beekmantown dolomite, with soft gneisses; Potsdam sandstone in lower amounts. In the above enumeration by township, the "Intermediate" and "Soft" types only were considered; but in the western part of the district the "Durable" stones, such as granites, syenites, sound gneisses, gabbros, predominate over all other kinds.

Laboratory Tests.

The system adopted during 1917 for the sampling of field stone deposits was entirely different from the one in use during the past years. The old method, which consisted of sampling a fence within a certain area, and assuming this to represent the average in composition of the area, has proved to be wholly unsatisfactory. The relative proportions of the different types of rocks vary greatly, not only from farm to farm, but even a particular fence may be altogether different from its neighbour. After many experiments conducted by L. Reinecke and K. A. Clark¹, it was found that all the various kinds of stone occurring within a certain area could be classified into three or four main types, the components of the same type having a nearly equivalent durability. Tests were run on each type in the laboratory, and it was discovered that if tests are made on mixtures in various proportions of the several types, the results of the tests are nearly identical with those obtained by calculation. If we represent by W_1, W_2, \dots, W_n the percentage of wear of the chief constituents, and by C_1, C_2, \dots, C_n the percentage proportions in which they occur in the mixture, the percentage of wear W_m of the mixture is given by the formula:—

$$W_m = \frac{\sum CW}{100}$$

Knowing the percentage of wear of the main types, the percentage of wear of any mixture of them is, therefore, easily found by calculation.

¹Reinecke, L., and Clark, K. A., "The Sampling of Deposits of Road Stone and Gravel in the Field;" Proceedings of the American Society for Testing Materials, Philadelphia, Pa., Vol. XVIII, Part II, 1918.

TABLE IV.

Results of Tests upon Field Stone.

Map No.	Location.	Type.	Wear, per cent.
43a	Lots 12, 19, Con. I, Charlottenburg.	Potash sandstone Coarse-grained Chazy limestone Chazy sandstone	2.7, 2.4, ave. 2.6 7.6, 8.1, " 8.0 3.7, 2.2, " 3.5
105	Lots 30, 31, Con. IV, Cornwall township	Igneous rock Potash sandstone Black River limestone	2.8, 2.9, " 2.7 2.4, 2.2, " 2.3 3.8, 3.9, " 3.0
131	Lots 13, 14, 15, Con. I, II, Osnabruck township	Chazy limestone	" 3.7

Service Tests.

For many years, crushed field stone has been extensively used for road surfacing in this district. Prior to 1914, all construction and maintenance work was done by statute labour, but in that year road work was taken up by the township council. The stone is laid in one layer, 8 to 12 inches in thickness, and 8 feet wide, without any rolling. The compacting is left to traffic, with the result that two deep ruts begin to form in the wheel tracks, and when these tracks have acquired a certain degree of smoothness, water is retained in the ruts, keeping them in a nearly constant moist condition. Bad drainage, whether due to ruts or insufficient grading, has been the most active cause of disintegration of road surfaces, since the few sections of road in good condition were found in places where the drainage was exceptionally good, either because of the relative elevation of the ground, or due to the firmness and porosity of the subsoil. For that reason, service tests do not give much information of value in regard to the durability of the stone in this district.

All roads surfaced in 1916 and 1917 were in bad shape, because of the stone not being sufficiently compacted. The best surfaces, found in the west end of the district examined, occurred in cases where old macadam or gravel roads had been resurfaced in 1914 and 1915. In the east end, old broken stone or gravel roads resurfaced in 1914, and under the same drainage and traffic conditions, were worn out after three years of service. All the country roads of this district are subjected to light traffic, rarely exceeding 100 vehicles per day.

Availability.

Boulder deposits are rare from Lancaster to the Quebec border, and the hauling distance from the nearest deposits to the front road is generally over one mile. Some other class of material will have to be used for the stoning of the river road. In Charlottenburg township, the amount of stone is sufficient to surface the road all along the shore, with a maximum hauling distance of 2 miles; except in the east end, where a longer haul is necessary. There may possibly be enough field stone in Cornwall and Osnabruck townships, figuring on a maximum hauling distance of $2\frac{1}{2}$ miles. Farther west, boulder deposits are of less frequent occurrence. The amount of stone within two miles of the shore is undoubtedly too small, so that some other kind of material will have to be employed for surfacing the front road. In the foregoing estimation, only the stone under 12 inches in size, is taken into account.

GRAVEL DEPOSITS.

The largest part of the gravel deposits lies between Cornwall and Aultsville. They occur less frequently east and west of this area. Most of the gravels east of Cornwall are found in the form of thin blankets, on top of boulder clay and closely associated with it. As far as could be ascertained from the few excavations, there is no distinct outline between the two kinds of deposits. West of Cornwall, in nearly every case, the gravels lie in the form of narrow ridges alongside the western edge of large boulder clay deposits. The gravels which are generally bouldery directly under the crest of the ridge, become finer and markedly stratified farther down. In many cases the extent of the gravel areas is uncertain, as surface indications were the only guide in determining the limits of the deposits.

Character.

All the information that could be obtained regarding the character of gravels is contained in Appendix III, page 34. The gravels are generally very coarse, and in several instances the deposits carry much more sand and boulders than gravel. Apart from a few exceptions, the gravels contain much stone of the same nature as the underlying rock. In Lancaster and Charlottenburg townships, the gravels carry much silt or fine sand, and a small proportion of pebbles. West of Cornwall, most of the gravel deposits are bouldery, but carry a sufficient proportion of stone of pebble size to differentiate them clearly from the boulder clay. In depth, the proportion of sand increases gradually as far as the underlying boulder clay.

TABLE V.
Tests made upon Gravels.

Map No.	Location.	Owners	Composition percentage of Impurities, clay, etc.				Per cent voids, material compacted.					
			Durable	Inter-mediate	Soft.	Specific gravity.	Per cent wear.	French coefficient of wear.	Concen-trating value.			
5	Lot 36, Con. I, Lancashire.	D. M. McCraig, Fisher P.O.	Traces of iron oxide	0	63	37	2.70	14.5	2.8	43	28.6	24.7
7	Lot 36, Con. I, Lancashire.	John Shanks, Lancaster P.O.	Little CaCO ₃ ...	0	70	30	2.70	8.6	4.6	67	25.2	22.2
13	Lots 4, 5, Con III, Charlottenburg.	Charlottenburg Council.	Traces of CaCO ₃ .	1	35	64	2.67	11.1	3.6	291	38.4	36.2
18	Lots 1, 2, Con. I, Charlottenburg.	A. J. Fraser, R.R.I., little CaCO ₃ and iron oxide.	5	10	85	2.66	4.7	8.5	156	34.3	28.9	
22	Lots 23, 24, Con. II, Charlottenburg.	Con. II, west. east of D. Richardson and Little CaCO ₃ and iron oxide.	3	50	47	2.68	8.3	4.8	186	28.5	24.7	
24	Con. II, west. east of D. Richardson and Little CaCO ₃ and iron oxide.	R. T. Doherty, R.R.I.	2	26	72	2.71	9.1	4.4	95	29.8	25.6	
27	Lots 7, 8, Con. II, Cornwall.	Manager C. L. Mongers, Cornwall P.O.	Some CaCO ₃ traces of iron oxide.	3	57	40	2.73	11.6	3.5	61	27.7	24.2
31	Lot 11, Con. V, Cornwall.	Father McBae, St. Andrews West P.O.	Some CaCO ₃ several shells.	2	76	26	2.60	5.1	7.8	91	23.4	21.3
32	Lot 12, Con. V, Cornwall.	John McIntosh, St. Andrews West P.O.	Traces of CaCO ₃ many shells.	3	60	37	2.67	5.2	7.7	188	28.8	27.3
37	Lot 29, Con. IV, Cornwall.	Thomas Cleary, Millie Rockes P.O.	Some CaCO ₃ many shells, much clay in one place.	0	52	48	2.72	7.6	5.3	79	23.0	19.6
43	Lot 22, Con. V, Cornwall.	H. Winters, Millie Rockes R.R. I.	Little CaCO ₃ traces of iron oxide.	3	69	28	2.70	6.64	6.3	64	19.9	16.8
46	Lots 30, 31, Con. VI, Cornwall.	U. J. McCullen, Hurst, R.R. I.	Some CaCO ₃ , little iron oxide. Several shells.	0	73	25	2.70	9.6	4.2	82	21.6	18.5

49	Lot 33 to 36, Con. V, Geo. Leesey, Harrison, R.R.	Some CaCO ₃ ,.....	0	80	20	2-67	12.5	3.2	148	30-6	26-5
50	Lot 33 to 36, Con. V, Wm. J. Murphy, Harrison, R.R. 1.	Traces of CaCO ₃ and iron oxide.	6	80	20	2-60	4-0	10-0	111	21-1	20-4
52	Lot 2, Con. II, Osma brick, J. G. Adams, Wales, R.R. 1.	Little CaCO ₃ , some iron oxide.	2	87	11	2-60	4-8	8-3	106	22-9	20-4
54	Lot 14, Con. I, Osma brick, James Miller, Wales, R.R. 1.	Little iron oxide; traces of CaCO ₃ . Some shells.	0	60	40	2-69	16.2	2-5	126	24-5	20-8
56	Lot 13, Con. III, Osma brick,	Lease of clay, a little iron oxide, some shells.	3	65	32	2-71	7-0	5-7	85	23-4	19-1
63	Lots 24 to 27, Con. IV, Osanabruk.	Osanabruk (tp. Council Part owned by W. N. Hollister, Faran Point, R.R. 1.) Many shells	0	60	40	2-69	5-3	7-6	80	23-5	19-0
75	Lots 26, 27, Con. III, Williamsonburg,	Malcoln A. Fouts Traces of clay and iron oxide, several shells.	1	64	35	2-70	13.2	3-0	89	26-8	22-1
79	Lot 35, Con. IV, Williamsonburg,	A. Shumard, Williamsburg, R.R. 1. Some CaCO ₃ and shale.	7	43	50	2-72	8-1	4-9	74	29-2	26-2
80	Lot 35, Con. III, Williamsonburg,	Asa Coulter, Williamsonburg, R.R. 1. Some CaCO ₃ , shale.	6	42	52	2-71	5-8	6-9	47	29-0	24-6
83	Lot 1, Con. I, Matilda burg P.O.	H. W. Doran, Morris-Traces of iron oxide	6	38	56	2-65	19.5	2-4	95	27-6	23-4
85	Lot 3, Con. I, Matilda burg P.O.	A. Beeksted, Morris-Much CaCO ₃ , a little clay.	6	50	44	2-71	6-3	6-4	59	27-6	24-4
86	Lot 5, Con. III, Matilda burg P.O.	W. Mullin, Iroquois-Some clay, a few shells.	0	64	36	2-71	9-7	4-1	95	29-8	24-5
87	Lot 19, Con. II, Matilda burg, Shaver, Iroquois, R.R. 2.	Edgar Shaver, Iroquois, R.R. 2. Traces CaCO ₃ and iron oxide, A few shells.	1	57	42	2-72	8-2	4-9	61	24-6	21-4
90	Lots 32, 33, Con. I, Matilda	Jay Mailey, Iroquois-Some CaCO ₃ traces	2	65	33	2-77	7-2	5-5	75	32-0	27-9
92	Lots 4, 5, Con. II, Ed. Wurzburg,	Rulus, Eromard, R.R. 2. Traces of iron oxide	4	55	41	2-77	13-5	3-0	61	28-9	28-2

TABLE VI.
Mechanical Analysis of Gravels.
(Stone over 3 inch not included.)

Map No.	Percentages retained on Screens and Sieves.										Total Passing 200 mesh
	21 in.	2 in.	1½ in.	1 in.	¾ in.	⅓ in.	3 mesh.	1½ mesh.	28 mesh.	48 mesh	
5	0·3	10·1	14·6	8·2	10·5	16·1	14·1	10·0	4·5	1·2	1·1
7	4·3	9·0	14·4	7·3	8·1	9·8	8·2	8·5	2·4	1·0	2·3
13	0·3	10·5	16·9	9·8	12·9	21·6	12·8	3·7	0·9	0·8	100·0
18	5·2	7·5	10·5	12·8	7·2	8·7	14·2	12·0	8·5	4·1	2·5
18	5·2	7·5	10·5	12·8	7·2	8·7	14·2	12·0	8·5	4·1	100·0
22	3·3	9·9	17·6	7·3	8·0	9·9	8·6	3·6	3·0	2·2	1·5
22	0·2	2·1	7·4	12·3	7·1	10·6	15·9	14·2	11·3	8·0	4·2
24	0·2	10·1	12·1	6·7	8·3	13·8	11·3	10·1	8·7	6·9	1·5
27	2·0	5·4	11·1	11·9	6·4	8·5	5·3	5·2	7·0	12·4	4·1
31	5·9	11·1	11·2	4·1	6·2	20·1	26·3	15·8	4·2	4·0	1·5
32	2·7	2·6	2·2	1·2	1·2	8·6	8·3	12·7	11·3	6·2	1·7
37	0·7	5·4	12·7	14·9	7·9	8·0	9·2	6·0	5·9	12·1	2·5
37	0·7	5·4	12·7	14·9	7·9	8·0	9·2	6·0	5·9	12·1	2·5
43	9·4	13·7	11·8	8·1	8·4	10·3	8·1	6·6	10·8	11·0	1·7
43	9·4	13·7	11·5	5·1	5·9	8·5	6·1	3·8	5·5	14·4	1·9
45	3·6	8·7	13·2	12·8	6·5	9·2	7·5	6·3	8·0	12·6	0·6
45	0·7	13·7	11·8	6·5	7·3	9·6	7·5	6·2	7·8	11·8	0·6
49	0·7	12·8	12·9	10·7	13·9	11·7	11·1	5·5	3·6	1·2	100·0
49	0·7	12·8	12·7	10·7	13·7	7·6	9·2	13·5	5·0	8·7	1·4
50	4·0	8·5	8·1	12·7	12·1	8·9	10·6	12·6	8·5	3·9	0·8
52	0·7	7·3	12·1	15·3	15·9	7·7	7·3	7·0	5·7	9·7	100·0
54	4·8	13·1	15·7	15·9	15·9	7·7	7·0	5·3	4·3	3·5	0·7
54	5·7	9·6	12·5	14·6	6·1	9·4	7·9	5·9	10·1	3·3	0·3
56	3·9	11·8	13·5	12·8	6·6	9·5	12·2	7·6	5·3	4·6	0·6
56	0·7	8·5	12·5	14·6	6·6	9·3	13·4	11·6	7·9	11·4	0·6
63	3·1	14·3	13·5	12·5	5·7	7·5	8·7	6·4	5·7	12·3	0·5
75	5·5	6·2	13·5	13·7	7·4	7·9	8·8	11·0	12·1	9·2	1·6
79	2·0	7·9	16·3	16·3	6·4	8·0	13·1	9·6	7·9	5·1	0·5
80	3·7	8·5	17·2	9·3	11·8	11·0	10·3	10·3	7·1	1·5	1·8
80	3·7	8·5	17·2	9·3	11·8	11·0	10·3	10·3	7·1	1·5	1·8
86	1·7	11·4	14·0	16·7	10·9	7·1	9·2	13·2	9·6	1·3	100·0
87	5·8	5·5	10·7	16·7	10·1	12·4	14·3	12·4	5·3	4·8	1·2
90	7·1	10·4	12·9	19·5	11·1	14·2	10·4	10·3	5·9	6·5	0·7
92	8·8	12·1	14·3	12·3	10·7	12·3	10·3	10·3	5·7	5·7	3·1
	9·6	14·6	5·8	7·4	7·4	9·2	9·2	7·4	5·6	7·8	1·2

Service Tests.

Gravel has been used for over thirty years in the surfacing of roads in the area examined. No extensive graveling has been done in the past few years. Most of the work consisted of surfacing short lengths of road each year, in places where it was badly needed. The same methods are used as in the case of field stone; and, besides, fresh and weathered gravels are used indiscriminately, so that little information can be obtained from service tests in regard to the quality of gravels as road material. The following is a brief enumeration of the gravels which have been used for road surfacing during the past few years.

Lancaster township.—Much gravel from deposit 5 was used long ago for road work. This deposit is nearly exhausted, and gravel is now taken from deposit 7. An old macadam or gravel road—resurfaced in 1915 with gravel from the latter deposit, and subjected to a traffic of a little over 100 vehicles per day—showed signs of wearing out after two years of service. Other old macadam roads resurfaced prior to 1915 with gravel from pits 5 and 7, were in very bad condition in the summer of 1917.

Charlottenburg township.—Gravel from deposit 24, used on a small piece of road subjected to light traffic, was completely worn out or sunk into the ground after three years. The subsoil at that place is rather unstable, and a larger amount of gravel should have been used, in order to obtain a hard and firm surface.

Cornwall township.—Gravel from pits 31, 40, 41, 43 and 49, has been extensively used in past years. More recently, much gravel has been taken out of pits 37, 45, 46 and 50, and laid on roads subjected to light traffic, with satisfactory results, in places where the subsoil was firm and well drained.

Osnabruck township.—Roads surfaced in 1913 and 1914 with gravel from pit 57 and with crushed boulders from pits 52 and 56 were in rather poor condition in 1917. A road surfaced in 1916 with crushed boulders from pit 63 showed signs of wearing out in 1917, but was in better condition than a part of the same road surfaced in 1916 with crushed field stone. Gravel from pits 65 and 66 was said to have been used in 1914 on a short length of the road from Aultsville to Gallingertown. It was in poor shape after three years service. Another part of the same road surfaced in 1915 with crushed field stone was in a much better condition. All the roads referred to in this township are submitted to a light traffic.

Williamsburg township.—Some of the main roads of this township were gravelled many years ago, and maintained with crushed field stone. Much material from pits 72, 73, and 80 has been used. In 1912 gravel from pit 79 was laid on the road nearby, which carries a very light traffic. It was in fair condition in the fall of 1917.

Matilda township.—Part of an old gravel road north of Iroquois was resurfaced a few years ago with gravel from pit 88. In well-drained places it is in fairly good condition, but very poor elsewhere.

Commercial Development.

All the information that could be obtained regarding the commercial development of gravels is contained in Appendix IV, page 50. No attempt has been made to estimate the quantity present in each deposit, because of the lack of reliable data.

The prices for gravel range from 10 to 50 cents, generally 25 cents per double load.

Lancaster township—Because of the great scarcity of field stone in this township, gravel will have to be used for surfacing the front road. Crushed gravel from deposit 7, which is the most important in this part of the district, could be advantageously used in the west half of the township. There is no good gravel available in the eastern half, but the large deposit of Riviere Baudet, which lies one mile outside of the Quebec border, could supply all the material necessary for this part of the township. The Riviere Baudet deposit is described in detail in the report "Road Materials in Soulanger and Vaudreuil Counties, Quebec," by L. Reinecke and R. H. Picher.

Charlottenburg township—The so-called gravel deposits of this township are closely related to boulder clay and sand, and are generally of poor quality. In the case of deposit 18, the per cent of "soft", which is marked as 85, and consists mainly of Chazy sandstone, is undoubtedly too high, as much of the Chazy sandstone should be more logically classified as "Intermediate", according to the results of laboratory tests made on that stone. Gravel from deposit 18 will have to be used in connexion with the stoning of the front road, as there is no other material available in the eastern part of this township. It is very bouldery, but once crushed should be a material of fair durability.

Cornwall township.—All the more important gravel deposits are located in the west half of the township. Most of them are very bouldery, and would have to be crushed. Deposits 31, 32, 33, 37, 40, 41, 43, 45, 46 and 50, are particularly suitable for road making, but, except in the case of 37, they all lie away from the front road, their hauling distance to that road varying from 2 to 6 miles.

Osnabruck township.—No large deposits are found near the shore. The best gravel areas of this township, Nos. 52, 56, 57, 59, and 63, lie at hauling distances varying from $2\frac{1}{2}$ to 5 miles from the front road. They are all very bouldery.

Williamsburg township.—Most of the deposits are of small extent, and several of them are nearly exhausted. Deposits 79 and 80, although inferior in quality to the Osnabruck and Cornwall townships deposits, are the best found in this locality. Both are bouldery. Because of the very small amount of stone available near the shore, especially so around Morrisburg, gravel from deposits 79 and 80 will probably have to be used, notwithstanding the long haul of $5\frac{1}{2}$ miles to the front road.

Matilda township.—There are no good gravels in this township. No. 85 in the east end, and 90 in the west end are of somewhat better quality than the rest. Both are bouldery. In order to provide a sufficient amount of stone for the front road in the east half of the township, it will be necessary to develop deposit 85, because of the scarcity of other kinds of material. In the west part, the necessary amount of stone can be taken out of the several bedrock exposures.

Edwardsburg township.—Only one large gravel deposit has been located in the small part of the township surveyed. It is of poor quality.

APPENDIX I.

Rock Outcrops.

(1) $1\frac{1}{4}$ miles southeast of Summerstown Station. Chazy limestone formation. Limestone is light grey, slightly banded, medium to coarse-grained, thick-bedded, but splitting up easily in thin layers. Beds have a gentle dip northwest. The stone taken out of an old quarry, 250 cubic yards in size, was used by the Grand Trunk Company, over 50 years ago, for bridges and culverts. There are no outcrops, and the overburden varies from a few inches to 2 feet in thickness. A few thousand cubic yards could be taken out in dry season, assuming an average depth of 1 yard. Owner: D. Cattanach, Summerstown Station, R.R. 1.

(2) 2 miles west of Summerstown Station. Doubtful outcrop of Black River limestone. The stone is dark, bluish-grey, fine-grained, with streaks of very dense stone, fossiliferous, breaking irregularly.

Flat blocks are seen on the surface of a small hill, in several parallel zones or ridges running approximately E. 7° N.

(3) 5 miles east of Cornwall. Doubtful outcrop of Chazy limestone. The stone is light grey, medium-grained, fossiliferous, thick-bedded, with shaly partings, splitting easily in thin layers. Several large blocks of limestone are seen on a hill, nearly all dipping in the same direction, i.e., 5 degrees north. Stone used for building cellars.

(4) 3 miles north of Cornwall. Black River formation. Dark, blackish-grey, very dense limestone, thick-bedded, with many shaly bands, splits up readily in thin layers. Beds apparently horizontal. Rock is seen at the bottom of a creek, and is overlain by 10 to 15 feet of boulder clay and sand. Quarrying here is out of the question.

(5) 3 miles north of Cornwall. Black River formation. Dark, blackish-grey, very dense, thick-bedded limestone. Beds lie apparently horizontal. One set of joints trends N. 18° E., glacial striae, N. 17° W. to N. 21° W. Rock seen at the bottom of a creek, 12 to 18 inches above low water-level, and overlain by 4 to 9 feet of boulder clay, with loam on top. Very little stone available.

(6) *4 miles north of Cornwall.* Black River formation. In a large quarry, 59,000 cubic yards in size, 69 inches exposed of dark, blackish-grey, very dense limestone, massive, large number of small calcite streaks; many shaly partings. The beds have a very gentle dip to the north. Irregular joints. Glacial striae N. 15° W. A few fossils.

Stone used 15 to 20 years ago for building the Cornwall canal banks and locks. There are only a few outcrops along south edge. The thickness of overburden around the quarry varies from a few inches to 10 feet. There are probably over 30,000 cubic yards available, figuring on an average depth of 2 yards. If quarried deeper, there would not be any means of draining except by pumping. Over 1,000 cubic yards of large blocks piled in quarry. Hauling distance of 5 miles to the front road. Owner: James McLeod, Cornwall, R.R. 2.

(7) *4 miles north of Cornwall.* Black River formation. In a large opening over 50,000 cubic yards in size there are $8\frac{1}{2}$ feet exposed of limestone, same as in No. 6, and dipping very gently to the north, strike E. 22° N., irregular joints. Glacial striae N. 19° W. In one place two sets of striae observed: N. 17° W. and N. 54° W. respectively. Stone used 15 to 20 years ago in the building of the Cornwall canal banks and locks. Outcrops are plentiful in the south half. Overburden, 3 to 24 inches of clayey loam, possibly thicker along north edge. On an average depth of 2 yards, over 90,000 cubic yards could probably be quarried. Deeper quarrying would necessitate pumping for draining the excavation, as underground water-level is actually 7 feet below the top of the rock. Hauling distance of $4\frac{1}{2}$ miles to the front road. Owner: F. J. Friend, Cornwall, R. R. 2.

(7a) *4 miles north of Cornwall.* Black River formation. A small opening, 593 cubic yards in size, shows a 5-foot section of dark, blackish-grey, very fine-grained limestone, dense, especially at the foot of the section, massive, although in the upper part it splits easily in thin layers, along shaly partings. Beds have a slight dip north. Joints irregular. Glacial striae N. 17° W. Stone was used, 15 to 20 years ago, in the building of the Cornwall canal banks and locks. Very few outcrops seen. Overburden at the quarry, from 1 to 3 feet of clayey loam with limestone boulders. At the house, southeast of quarry, according to owner, the rock is 7 feet below the surface. A few hundred cubic yards could still be quarried. Owner: A. E. O. Clark, Cornwall, R. R. 2.

(8) *$3\frac{1}{2}$ miles north of Cornwall* Black River formation. In the bottom of a shallow creek, a few inches exposed of very light bluish to greenish-grey, medium-grained limestone; the stone separates readily in thin layers along shaly partings. Weathers dark buff in colour and shows some silt. Beds apparently horizontal. Directions of joints: N. 49° E. and E. 2° N. No outcrops. Overburden, from 18 to 24 inches. At house near cheese factory the rock lies 9 feet below the surface. Bad drainage renders quarrying impracticable.

(9) *2 miles north of Mille Roches.* Black River formation. In the lower bank of a creek there is one bed, 13-inch thick, exposed, of blackish-grey, very dense limestone; large number of fossils. Beds apparently horizontal. The rock is 13 inches above low-water level, with a minimum thickness of 4 feet of overburden on top of the rock. There are no outcrops, and quarrying would be very difficult.

(10) *1 mile north of Mille Roches.* Black River formation. In a quarry of 5,580 cubic yards there are 6½ feet exposed of very dark, blackish-grey, very dense limestone, massive. Many shaly partings cause the stone to break irregularly; some fossils. Beds have a very gentle dip south. Joints irregular. Glacial striae N. 13° W. Stone used 15 to 20 years ago in the building of locks and part of bank of the Farren's Point, Morrisburg and Cardinal canals. Owners received 10 cents per yard unquarried. Outcrops are plentiful within the east half of the mapped area. Overburden, ½ to 3 feet of bouldery loam, probably over 3 feet to the west. There would probably be about 30,000 cubic yards of rock available, quarrying at an average depth of 1½ yards, and with not over 2 feet of overburden. If quarried deeper, provision would have to be made for drainage. Hauling distance: 1½ miles to the front road, canal, and railway siding. Owner: Philip T. Empey, Mille Roches, R. R. 1.

(11) *1½ miles north of Mille Roches.* Black River formation. Large opening, full of water, the top of the rock being a few inches below water-level. Blackish-grey, very dense limestone, massive. Beds nearly flat. The opening has an area of 12,000 square yards. Stone used for building canal banks. No outcrops. Overburden, over 3 feet of loamy clay. No more stone available. Owner: James Henderson, Mille Roches, P.O.

(12) *1½ miles north of Mille Roches.* Black River formation. Large opening nearly full of water. The rock is under water-level, except in the south end, where at one place a 6-foot exposure is seen. Dark, blackish-grey, very dense, massive limestone, with many shaly partings, causing the stone to break irregularly. Beds have a gentle dip to the north. The opening has an area of 16,000 square yards. Stone used for building canal banks. No outcrops. Overburden, a few inches of loam and black muck in the south end, 8 feet of loamy clay in the north end. Quarrying would be very expensive. Over 10,000 cubic yards of waste stone have been dumped in big piles around the quarry, the largest part is under 1 foot in size. Owner: U. E. Thompson, Moulinette, P.O.

(13) *1½ miles north of Mille Roches.* Black River formation. In the south end of a large excavation, 12,000 square yards in extent, and nearly full of water, there is a 3-foot section above water-level of limestone of same character as No. 12. Beds nearly horizontal. Stone used for building canal banks. Overburden, over 5 feet of loamy clay. Quarrying would be very expensive. Over 1,000 cubic yards of waste stone dumped in 2 piles west of quarry, largely under 1 foot in size. Hauling distance of 2 miles from the front road, canal and railway siding. Owner: William Manson, Mille Roches, P.O.

(14) *1½ miles north of Mille Roches.* Black River formation. Old quarry, nearly full of water. Rock above water-level in the southwest end only. Dark, blackish-grey, very dense limestone, massive, with a few shaly partings. Beds lie nearly horizontal. Stone used for building canal banks. The quarry occupies an area of 5,250 square yards. Overburden, a little over 2 feet in the southwest end of quarry, and goes over 4 feet everywhere else. Quarrying would be expensive. Hauling distance of 2½ miles to the front road, canal and railway siding. Owner: G. Brooks, Mille Roches, P.O.

(15) *1½ miles northwest of Mille Roches.* Black River formation. Large quarry nearly full of water. All rock is under water-level, except in the east end, where it is 63 inches above water-level. Dark, blackish-grey, very dense, massive limestone; small streaks of calcite crystals; fossils. Stone splits irregularly in thin layers along shaly partings. Beds have a very gentle dip north or northwest. Glacial striae; N. 13° W. and N. 9° E. The opening covers an area of about 24,000 square yards. Stone used in the building of the locks and parts of the banks of the Cornwall, Farran's Point, Morrisburg and Cardinal canals, 15 to 20 years ago. No outcrops. Overburden, 3 feet of clayey and silty loam in the east end of the quarry, and over 6 feet everywhere else. Quarrying would be very expensive. Over 10,000 cubic yards of waste stone dumped in 3 piles south of the quarry. Hauling distance of a little over 2 miles to the front road, canal, and railway siding. Owner: Miss Copeland, Cornwall, P.O.

(16) *1½ miles northwest of Iroquois.* Beekmantown formation. Light steel grey, fine-grained, thin-bedded dolomite, weathering to light buff colour. Beds appear to lie flat. Stone used for making lime many years ago. Outcrops plentiful and overburden, apparently not over 2 feet, consists of dark brown loam. The rock lies in a low place. Over 5,000 cubic yards available without much stripping. Hauling distance, 1½ miles to the front road and canal. Owner: R. A. Carman, Iroquois, P.O.

(17) *1 mile west of Iroquois.* Beekmantown formation. In an opening, 3,170 cubic yards in size, there are 3½ feet exposed of rather dark earth-grey, fine-grained, thick-bedded dolomite, with a few shaly partings; splits in thin layers. Slight amount of silt in the weathering. Beds have a very gentle dip west. Strike N. 9° E. One direction of joints trends N. 29° E.

Stone used as back filling for the canal locks at Iroquois, 15 to 20 years ago. The stone has not been used on roads, but the canal road from the quarry east to Iroquois is said to be surfaced with stone blasted out of the canal, 15 to 20 years ago, and has never been repaired since. In the fall of 1917, the road was in very bad condition, full of ruts, and many large stones exposed. No more stone can possibly be quarried because of the limited area, and of the difficulty of draining. The rock lies within 250 yards of the front road and canal. Stone sells at 50 cents a cord, unquarried. Owner: William Fisher, Iroquois, P.O.

(18) *1 mile west of Iroquois.* Beekmantown formation. In small quarry, 320 cubic yards in size, there are 2 feet exposed of dark grey, fine-grained, thin-bedded dolomite. Slight amount of silt in weathering. Beds have a very gentle dip to the west or southwest. Stone said to have been used as back filling for the canal locks at Iroquois, 15 to 20 years ago.

Very few outcrops seen north of the quarry. Overburden, a few inches to 2½ feet of clayey loam. Over 2,000 cubic yards could probably be obtained. The rock is right along the front road and canal. Owner: A. H. Hutchison, Iroquois, R. R. 2.

(19) *3 miles northeast of Cardinal.* Beekmantown formation. Light clay-grey, finely grained, rather brittle, thick-bedded dolomite, slightly

weathered with silt in the weathering. Beds have a very gentle dip to the southwest. Irregular joints. Stone used for building the Methodist Church in Iroquois, and the owner's house, 35 years ago. The overburden consists of from 2 to 4½ feet of boulder silt and clay. Further quarrying would be expensive, because of the great thickness of drift. The hauling distance is half a mile to the front road and canal. Owner: J. T. Liezert, Iroquois, R. R. 2.

(20) *3 miles northeast of Cardinal.* Beekmantown formation. About 1 foot exposed of dark brownish-grey, medium to fine-grained, banded dolomite, partly weathered with silt in the weathering. Beds lie horizontally. For future development see No. 21.

(21) *3 miles northeast of Cardinal.* Beekmantown formation. A 2-foot bed exposed of rather dark grey, finely grained, dolomite, with several shaly partings. Splits readily in thin slabs, 1 to 4 inches thick. Beds have a very gentle dip west. Irregular joints. Outcrops are plentiful, with overburden of from 2 to 12 inches of bouldery sand in west part and clayey loam in east end. The stone is easy to quarry, but could not be excavated farther down than 2 yards, on account of the difficulty of draining. Hauling distance of ½ mile to the front road and canal. Stone sells at 50 cents per cord (128 cu. ft.) unquarried. Owner: J. T. Liezert, Iroquois, R. R. 2.

(22) *3 miles north of Cardinal.* Beekmantown formation. Thin-bedded, rather light grey, fine, even-grained dolomite, weathering to a dark grey and buff colour, with silt in the weathering. Beds have a very slight dip northwest; striae N. 24° E. One direction of joints trends E. 1° S. Two series of glacial striae: N. 18° E. and N. 12° W. respectively. Stone used for building houses in the vicinity 40 to 60 years ago. Outcrops are numerous, with a few inches of boulder clay as overburden, excepting a small sand ridge 5 feet in height, which partly covers the northern part of the area. Several thousand cubic yards of stone can be easily obtained. Hauling distance of 2½ miles to the front road and canal. Owner: William Warren, Iroquois, R. R. 2.

(23) *3 miles north of Cardinal.* Beekmantown formation. In shallow quarry, a 2-foot section of thin-bedded, fine-grained, rather dark grey dolomite, with a few shaly partings; splits up readily in thin slabs. The dolomite weathers to a dark grey, with spots of buff colour, small amount of silt in the weathering. In the east end of the deposit, in a small quarry about 50 cubic yards in size, there is a 2½ - foot section of very light, reddish-grey, finely grained, thin-bedded, dolomite, with a few calcite crystals and nodules of quartz. Very gentle dip northwest, increasing to nearly 5 degrees farther down the slope. Striae N. 44° E. One direction of joints runs N. 24° E. Stone used for building cellars. It sells at \$3.50 per cord (128 cu. ft.) quarried, or 50 cents unquarried. Outcrops are seen along the west and east edges, but none in the centre of the area. The overburden on both edges consists of from 4 to 12 inches of loam. Its thickness at the centre is unknown. The stone is easy to quarry, and over 10,000 cubic yards could be obtained along the east and west edges. Hauling distance of 3 miles, of which half a mile is through fields, to the front road and canal. Owner: John Bueley, Iroquois, R. R. 2.

(24) *3 miles north of Cardinal.* Beekmantown formation. About 2 feet exposed of same dark grey dolomite as seen in No. 23. Outcrops on top and northwest slope of a low hill. Very gentle dip to the northwest, increasing to 5 degrees farther down the slope. Striae N. 34° E. One direction of joints runs N. 16° E. Stone sells at \$3.50 per cord quarried, or 50 cents per cord unquarried. Owner: William Shaver, Iroquois, R. R. 2 For future development see No. 23.

(25) *1½ miles west of Cardinal.* Beekmantown formation. In a large quarry, over 70,000 cubic yards in size, 23-foot section exposed above ground water-level. In the 16 feet immediately above water-level, the stone is dark brownish-grey, medium to fine-grained, thin-bedded dolomite. On the top a 7-foot section of intensely weathered dolomite is seen only at one place in the quarry. Beds have a very slight tip to the northwest. Striae N. 44° E. Irregular joints. Stone used many years ago for building houses, and later in the building of the Cardinal canal. Overburden, from 1 to 4 feet of loamy silt and sand. Outcrops around a flat-topped hill in the lower part of the slope. The thickness of drift on top of the hill is not known. Several thousand cubic yards can be obtained in the old excavation and from the belt of outcrops around the hill. The deposit is close to the front road and canal. Caretaker: G. F. Adams, Cardinal, P.O. (See Plate VI).

APPENDIX II.

Character of Boulder Deposits or Field Stone.

Explanation of Table. Glacial boulders, strewn over the land which has been cleared, have, for the most part, been piled in fences or heaps. The composition of the boulder aggregates has been estimated, and the amount of stone present measured, fence by fence, and pile by pile. The amount under and over 1 foot has also been estimated fence by fence. Groups of fences and piles were combined into areas, and the total yardage and the average composition for the areas compiled and calculated from the results obtained on each fence. Each area is numbered on the map, and the information regarding it will be found accompanying this number in the table. Durable boulders in this classification represent igneous rocks, hard gneisses and quartzites; intermediate represent limestones, dolomites, dense and hard sandstones, softer gneisses and partly weathered durable rocks; soft boulders represent sandstones, shales and much weathered rocks.

Abbreviations used in column for remarks.

anor.....	anorthosite.
Beekman.....	Beekmantown.
Blk. R.....	Black River.
Ch.....	Chazy.
dol.....	dolomite.
gb.....	gabbro.
gn.....	gneiss.
gr.....	granite.
gr.-gn.....	granite-gneiss.
lst., limest.....	limestone.
Pot.....	Potsdam.
ss., sandst.....	sandstone.
sy.....	syenite.
Tr.....	Trenton.

CHARACTER OF DEPOSITS OF FIELD STONE.

Lancaster Township.

Map No.	Location.	Field estimate of composition.						Remarks.	
		Average of whole deposit			Cubic yds. of stone, diameter,				
		Material under 1 ft.	per cent of	Material over 1 ft.	per cent of	Under 1 ft.	Over 1 ft.		
		Durable	Intermediate	Soft.	Durable	Intermediate	Soft.		
1 Con II, lot 8		11	59	30	18	45	21	111 152 145	
2 Con II, lot 10		20	40	40	20	25	35	21 36	
3 Con II, lot 12								700 687	
4 Con II, lot 17		0	35	65	0	27	14	Con II, lot 17 Heavy limestone, Perkin's claim soft, weathered, sandstone Massly dolomite and limestone	
5 Con II, lot 17		0	37	63	0	62	26	45 45 45	
6 Con II, lots 19, 20		0	39	70	0	60	49	123 123 123	
7 Con II, lot 20		0	39	70	0	60	45	123 123 123	
8 Con II, lots 21, 22		2	48	50	1	68	25	25 25 25	
9 Con II, lot 24		0	40	60	0	30	10	14 14 14	
10 Con II, lot 24		4	52	43	11	72	16	142 142 142	
11 Con II, lot 25		0	74	26	0	56	14	111 111 111	
12 Con II, lot 27		0	75	25	0	85	15	72 72 72	
13 Con II, lots 28, 29		1	53	46	26	48	14	117 117 117	
14 Con I, lot 28		0	59	50	0	50	30	232 232 232	
15 Con I, lot 29		0	60	41	0	80	29	45 45 45	
16 Con I, lot 25		0	41	59	0	60	25	25 25 25	
17 Con I, lot 27		0	80	20	0	90	10	13 13 13	
18 Con I, lot 32								62 62 62	
19 Con II, lot 38		6	51	40	36	36	8	75 75 75	
								37 37 37	
								1633 1634 1634	
								3317 3317 3317	

Charlottenburg Township.

20 Con I, lots 58, 59	25	70	5	25	70	5	39	147
21 Con I, lot 58	30	60	10	30	60	10	53	145
22 Con II, lot 1							53	125
23 Con IV, lot 2							177	206

Massly limestone, a few ft. sandstone
Upper strata to draw out, movement
(the surface) character of the soil and
the very poor condition of roads.

Charlottenburg Township—(Concluded).

Map No.	Location.	Field estimate of composition						Cu. yds. of stone, diameter, Ref. No.			
		Average of whole deposit			Material over 1 ft.; per cent of						
		Material under 1 ft.; per cent of	Durable	Intermediate	Soft	Durable	Intermediate	Soil	Under 1 ft.	Over 1 ft.	Total
56 Con I, lot 38	14	60	26	60	10	43	47	90			
57 Con I, West end	14	66	27	65	20	1,275	2,064	3,339			
58 Con I, West end	23	40	35	45	35	135	254	419			
59 Con I, West end	10	40	30	10	55	35	68	103	171		
60 Con I, West end	13	55	30	24	44	32	629	627	1,256		
61 Con II, West end	28	47	25	45	40	15	3	55	58		
62 Con II, West end	10	35	25	27	43	30	237	291	528		
63 Con II, West end	10	46	44	10	45	30	304	282	646		
64 Con I, II, West end	10	47	43	18	43	39	3,482	3,621	7,103		
65 Con I, West end	10	65	30	10	60	30	462	304	763		
66 Con I, West end	5							31,812	26,265	58,077	

In No. 55, about 200 cu. yds. of scattered boulders.

About 200 cu. yds. of scattered boulders.

Can be drawn out only in dry season on account of soft soil and bad roads.

Dur.—Gn. gr.-en. gr.
Inter.—Pot. and Chazy ss. Beckman-
town dol. Soft... Chazy dol. and Pot-
town sand-stone.

Can be drawn out only in dry season
Uniform in composition

Cornwall Township.

Map No.	Location.	Field estimate of composition						Cu. yds. of stone, diameter, Ref. No.			
		Average of whole deposit			Material over 1 ft.; per cent of						
		Material under 1 ft.; per cent of	Durable	Intermediate	Soft	Durable	Intermediate	Soil	Under 1 ft.	Over 1 ft.	Total
67 Con I, lot B	25	50	40	50	10	74	32				
68 Con I, lots C, D.	23	54	23	62	30	8	130				
69 Con I, lot D	0	60	40	10	70	20	12				
70 Con I, lots B, C, D	1	62	37	30	55	15	960				
71 Con I, lots A, B.	5	70	25	20	70	10	151				
72 Con I, lots A, 1	5	69	26	35	55	10	53	37			
73 Con I, lots 1, 2, 3	23	54	23	61	31	8	265	402			
74 Con I, lots 3, 4	31	48	31	63	26	9	88	124			
75 Con I, lots 6	1	60	35	41	45	14	80	162			
76 Con II, lots 7, 8	9	61	30	26	26	8	149	218			

Impenetrable to draw out.

Can be drawn out only in dry season.

About 100 cu. yds. of scattered boulders.

Dur.—Gn. gr.-en. gr.
Inter.—Pot. and Chazy ss. Beckman-
town dolomitic limestone; some Beck-
man dolomitic and Chazy ls.

Soft. Chazy shales and weathered
stones.

Dur.—Gr. gr. ss.

Inter.—Pot & Chazy limestone Black River
lime. Beckmantown dolomite.

Cornwall Township—(Concluded).

Map No.	Location.	Field estimate of composition.						Remarks.	
		Average of whole deposit.			Cu. yds. of stones, diameter.				
		Material under 1 ft.; per cent of.		Material over 1 ft.; per cent of.		Under 1 ft.	Over 1 ft.		
Durable.	Inter-mediate.	Soft.	Durable.	Inter-mediate.	Soft.	1,331	1,411	2,742	
109 Con. V, lots 31 to 34	16	55	29	23	54	23	1,331	60 cu. yds. in piles. A few hundred cu. yd. of boulders scattered on hill.	
110 Con. IV, lot 33	15	60	25	26	40	34	102	107	
111 Con. V, lots 34, 35	15	52	33	36	39	25	1,075	300	
112 Con. V, lots 33, 36	10	50	40	38	48	14	207	256	
113 Con. V, lots 36, 37	38	40	22	24	45	31	375	381	
114 Con. V, lots 36, 37	12	52	36	31	50	19	444	756	
115 Con. III, lots 36, 37, 38	10	60	30	40	40	20	103	115	
116 Con. IV, lot 34	25	45	30	47	38	15	92	218	
						333	425	425	
						16,406	13,624	30,032	

Osnabruck Township.

117 Con. I, lot 1, part in Cornwall	10	65	25	20	65	15	602	493	1,005
118 Con. I, lots 1, 2, 3	16	50	34	50	40	10	97	5	102
119 Con. I, lot 2	38	40	22	63	27	10	122	72	194
120 Con. I, lots 2, 3, 4	5	60	35	15	55	30	11	93	104
121 Con. I, lots 1, 2, 3	21	50	29	32	42	26	614	1,086	1,722
122 Con. I, lot 4	20	50	20	60	31	9	35	76	111
123 Con. I, lot 5				70	20	10		56	56
124 Con. I, lot 6				80	10	10		59	159
125 Con. I, lot 7	35	40	25	65	25	10	117	111	228
126 Con. I, lot 10	19	49	22	72	22	6	77	53	130
127 Con. I, lots 6, 7, 8	38	39	23	62	28	10	1,147	546	1,663

28

15 cu. yds. in piles.
 Dur.—Gr. gr.—gr. a few anor.
 Int.—Pot. sandstone.
 Soft.—Weathered stones.
 Inter.—Black River and Beekmantown limestone.
 Black River lat and some Chazy.
 Soft.—Weathered stone.
 Int.—Pot. sandstone.
 Black River lat and some Chazy.
 Soft.—Weathered stone.

77468-31

128 Con. I, lot 9	32	30	18	14	6	40	45	86	421
129 Con. I, lots 10, 11	19	50	44	42	14	826	248	1,074	Dur. — Gr. gr. sy. a few gabbros.
130 Con. I, lots 10, 11, 12	16	52	32	40	13	1,300	2,461	2,461	Iner. — Black River and Chazy ls.
131 Con. II, lots 13, 14, 15	19	49	32	30	14	1,369	761	2,130	Potsdam sandstone, Soft Chazy and son. Bl. River ls., weathered stones in No. 13, Durable in higher proportion in the north part, Iner.
132 Con. I, lots 15, 16, ...	0	66	34	20	62	16	274	147	Dur. — Ga. gr. a few fabbros.
133 Con. I, lots 11, 12	40	38	22	66	22	10	890	670	Iner. — Black River ls.
134 Con. I, lot 11, ...	38	36	26	55	30	15	47	37	Soft. — Chazy and Potsdam sandstone.
135 Con. I, lots 13, 14	42	39	28	74	17	9	324	311	Dur. — Gr. gr. sy. gabbro.
136 Con. I, lots 13, 14	39	36	63	23	14	158	83	241	Iner. — Potsdam sandstone, Black River and Chazy ls.
137 Con. I, lot 16	25	35	60	35	5	21	31	52	Dur. — Gr. gr. sy. a few anor.
138 Con. I, lot 18	50	29	65	25	10	70	26	96	Iner. — Black River and Chazy ls., Potsdam sandstone.
139 Con. I, lot 18	5	30	43	46	11	74	171	245	Soft. — Pot. ss., weathered stones. About 250 cu. yds. of scattered boulders. In the stone under lft. there is no Durable east of the road, while there is as much as 35 per cent west of road.
140 Con. II, lot 17	15	27	26	38	16	177	43	220	Dur. — Gr. gr. sy. a few anor.
141 Con. II, lot 19, 20, ...	13	59	26	35	9	1,131	520	1,651	Iner. — Black River and Chazy ls., Potsdam sandstone.
142 Con. II, lot 20	0	82	18	13	82	5	43	25	68
143 Con. II, lots 18 to 23	25	52	23	63	26	9	384	394	Dur. — Gr. gr. sy. a few fabbros.
144 Con. I, lot 19, ...	50	30	20	65	30	5	35	11	Iner. — Black River ls. Potsdam sandstone.
145 Con. I, lot 23	50	30	20	80	15	5	7	47	Soft. — Sandstones, weathered stones.
146 Con. I, lot 24	41	39	20	67	28	5	71	17	30 cu. yds. of scattered boulders.
147 Con. I, lot 24	42	36	20	70	25	5	28	46	Dur. — Gr. gr. gabbro.
148 Con. II, lots 25, 26	17	53	30	34	16	84	8	74	In con. II, from lots 24 to 31, there are about 100 cu. yds. of scattered boulders.
149 Con. II, lots 26 to 31	19	49	32	47	43	10	296	26	92
150 Con. I, lot 27, ...					60	30	10	19	322

Osnabruck Township—(Concluded).

Map No.	Location.	Field estimate of composition.						Cu. yds. of stone, diameter.	Remarks.	
		Average of whole deposit.			Material over 1 ft.; per cent of.					
		Material under 1 ft.; per cent of.		Durable	Intermediate	Soft	Intermediate	Soft	Under 1 ft.	Over 1 ft.
131 Con. I, lot 29...		20	50	30	30	40	10	720	80	200
132 Con. I, lots 28, 29, 30...		26	44	58	32	10	54	171	225	Dur.—Gr. & sy., a few gabbro & sand.
133 Con. I, lot 31...		6	51	45	43	12	231	95	326	Inter.—Poudam sand., Black River & Chazy lat., some gr. & soft.
134 Con. I, lots 33, 34...		20	50	30	80	10	10	5	12	Dur.—Gr. & sy., a few sy.
135 Con. II, lots 33, 34...		10	43	60	30	10	104	6	110	Inter.—Chazy & Black River lat.
136 Con. I, lot 37...		30	40	30	60	30	10	12	8	Sgt.—Chazy lat., weathered stones.
							11,716	7,894	19,610	

Williamsburg Township.

157 Con. I, lots 1, 2...	13	53	34	62	28	10	32	10	42	Dur.—Gr. & sy., few gabbro.
158 Con. I, lot 6...	20	50	30	60	30	10	22	9	22	Inter.—Black River and Chazy limestone, some Poudam sandstone.
159 Con. I, lot 8...	24	41	35	60	30	10	122	9	131	Soft.—Chazy limestone, some weathered stones.
160 Con. II, lot 12...	20	50	30	65	24	11	15	275	361	Dur.—Sy., gr. & sy., gabbro, Inter.—Limestone, Poudam sandstone.
161 Con. I, lots 3, 4...	26	44	30	65	24	11	15	275	361	Soft.—Chazy limestone, weathered stones. Can be drawn out only in dry weather.
162 Con. I, lot 6...	20	50	30	66	24	10	11	213	213	
163 Con. I, lot 10...	25	45	30	66	24	10	105	162	162	Several hundred cu. yds. of piled stone, east of side road.
164 Con. II, lot 13...	25	48	27	66	24	10	57	57	57	
165 Con. II, lots 15, 16	35	42	23	67	93	10	200	38	238	Dur.—Gr. & sy., gr. & sy., few gabbro

(Matilda Township—Concluded).

Map No.	Location.	Field station of composition						Remarks.	
		Average of whole deposit.			Cu. yds. of stone, diameter.				
		Material under 1 ft.; per cent of	Material over 1 ft.; per cent of		Under 1 ft.	Over 1 ft.	Total.		
Durable	Intermediate	Soft.	Durable	Intermediate	Soft.	Under 1 ft.	Over 1 ft.		
188 Con. I, lot 19.	10	60	30	23	15	200	200	Dur.—Gr. sy. gr.-gr. sy., gabbr., few sy., gabbr.,	
189 Con. I, lot 19.	5	76	19	53	11	138	139	Inter.—Beekmantown dolomite, and few sandstones.	
190 Con. I, lots 20, 21.	6	67	27	45	25	182	173	Inter.—Gr. sy. gr.-gr. sy., gabbr., few sandstones.	
191 Con. I, lots 21, 22.	10	66	24	62	10	146	94	Inter.—Beekmantown dolomite and other stones.	
192 Con. I, lot 23.	8	68	24	62	28	96	55	Inter.—Weathered Beekmantown dolomite and other stones.	
193 Con. I, lots 24, 25.	17	60	22	80	10	32	16	Inter.—Gr. sy. gr.-gr. sy., gabbr., few sandstones.	
194 Con. I, lot 21.	0	80	20	80	10	93	58	Inter.—Beekmantown dolomite, few sandstones.	
195 Con. I, lot 22.	40	40	20	70	20	14	22	Inter.—Beekmantown dolomite, few sandstones.	
196 Con. I, lot 22.	36							Soft.—Weathered Beekmantown dolomite and other stones.	
197 Con. I, lots 25, A.	7	67	26	67	22	11	175	102	
198 Con. I, lot 25.	47	35	18	78	12	10	491	333	
199 Con. I, lot 26.	35	27	18	85	9	6	915	1,243	
200 Con. I, lot 27.	60	27	13	84	10	6	277	306	
201 Con. I, lot 30.	67	1	16	65	9	6	127	279	
202 Con. I, lots 31, 32.	50	28	22	77	13	10	264	406	
203 Con. I, lot 32.	53	22	20	78	14	10	413	664	
204 Con. I, lots 32, 33.	30	43	22	70	20	10	413	513	
205 Con. I, lot 34.	26	49	25	70	20	10	167	87	
206 Con. I, lots 33, 34.	39	41	20	74	15	10	282	76	
207 Con. I, lots 34, 35.	33	43	24	77	15	10	106	358	
208 Con. I, lot 34.	44	36	20	70	20	10	110	125	
209 Con. I, lot 29.	50	30	20	70	20	10	55	83	
210 Con. I, lots 30, 31.	20	48	26	70	20	10	157	164	
211 Con. I, lot 31.	20	45	35	60	30	10	12	28	
212 Con. I, lot 32.	20	50	30	63	27	10	210	60	
213 Con. I, lots 31, 32, 33.	31	43	26	74	16	10	797	602	
214 Con. I, lot 32.	55	25	20	74	16	10	44	111	
215 Con. I, lot 35.	29	44	27	77	13	10	140	425	
216 Con. I, lots 36, 38.	25	33	33	69	21	10	82	79	
								6,725	
								7,364	
								14,092	

1.728	7.34	14.092
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Edwardsburg Township.

APPENDIX III.

Character of Deposits of Gravel.

Explanation of Table. The estimates of the character of the gravels were made in such excavations as could be found in the deposits, or from surface indications where there were no excavations. Since parts of the walls in nearly all the pits are talus-covered, and the pits are usually small in proportion to the deposit, the estimates are only an approximation to the true character of the deposit. This is especially so in the proportion of boulders, gravel and sand, which nearly everywhere vary greatly from place to place in a body of gravel. The compositions of the pebbles also vary, but not as a rule to so great an extent. The impurities mentioned include the clay, iron oxide, lime carbonate (CaCO_3), organic matter, etc., found below the zone of weathering; except in cases where practically all of the gravel is weathered. The pebbles have been classified according to composition into three classes, durable, intermediate, and soft. The average results of laboratory tests made upon many samples of rock have been tabulated by Lord.¹

Durable pebbles in the following table are those made up of rocks averaging from 2·2 to 3·9 per cent of wear, and 12 to 25 in toughness; intermediate 4 to 5·6 per cent of wear, and toughness 5 to 12; soft, per cent of wear 5·6 and over.

The mechanical analysis covers only the material under 3 inches in size.

¹Lord, E. C. E., "Relation of Mineral Composition and Rock Structure to the Physical Properties of Road Materials." U.S. Dept. Agric., Bull. 348, p. 2, Washington, D.C. 1916.

Lancaster Township.

Map No.	Depth of Weather.	Percentage.		Shape of Pebbles.	Impurities.	Percentage.	Int.	Soft.	Remarks.
		Boulders over 3 in.	Gravel 1 to 3 in.						
1	4	25	50	25	Small amount of clay and CaCO_3 .	3	35	60	Estimate made in the northeast bank on a depth of 4 feet. Coarse, weathered gravel. The pebbles are mostly Chazy limestone and sandstone.
2	.....	.....	.....	.....	Angular.	10	10	80	Estimates from surface indications. Medium coarse gravel. The pebbles consist of limestone, dolomite, sandstone (all weathered).
3	2 to 2½	25	24	51	Traces of CaCO_3 . Traces of FeO_3 .	3	54	43	Depth of pit: 7 feet, nearly all uncovered; pit walls stand up well. Estimates made in the east bank. No variation as to size. Rather sharp outline between weathered and fresh part, with a layer, 1 to 1½ in. thick, of CaCO_3 between the two parts. The material under 1 inch consists of limestone particles in a matrix of silt grading into fine sand. Looks much like a boulder clay deposit, few of pebbles in Chazy limestone, part being white.
4	2	5	40	55	Angular.	0	84	16	Mechanical analysis: Retained on 3 mesh sieve... 32% " " 8 " 13 " " 20 " 6 " " 48 " 23 Passing " 26
5	3	0	53	47	Traces of FeO_3 .	0	63	37	Two feet weathered gravel exposed in road cut. Largest part in Chazy limestone. Sieve analysis: Retained on 3 mesh sieve... 53% " " 5 " 16 " " 20 " 1 " " 48 " 21 Passing " 1-5

Lancaster Township—(Continued.)

Map No.	Depth of Weathering (in feet),	Percentage.		Impurities.	Shape of Pebbles.	Dur.	Int.	Soft.	Percentage.	Remarks.
		Boulders over 3 in.	Gravel 1 to 3 in.							
6	.....	.....	.....	CaCO ₃ , FeO, Clay, etc.	.....	.....	.....	.....	.....	Small pit showing bank with a streak of gravel, 8 ft. wide in the north bank. About the same character as No. 5.
7	5	35	38	27	Small amount of Sub-angular CaCO ₃ .	0	70	20	.....	Estimated made in the north bank. Looks somewhat coarser in the northeast bank. (River side) of the pebbles in Chazy limestone. Sample tested.

Charlottenburg Township.

8	2	10	49	41 Traces of C ₂ CO ₃ , traces of Fe ₂ O ₃ .	Angular to sub-angular.	0	47	53	.....	Over 6 feet of face seen, in east part. The lower part of the face is new bouldery and shows a well-marked stratification. Large number of shells up to 1 inch in size. Gravel uniform in size. 75 % of pebbles in limestone.
9	2+	.....	.....	.....	Angular to sub-angular.	.....	.....	.....	.....	Retained on 3-inch sieve. 34%.
10	.....	.....	.....	.....	Angular to sub-angular.	.....	.....	.....	.....	Retained on 1/2-inch sieve. 11%.
11	2+	.....	.....	.....	Angular and sub-angular.	.....	.....	.....	.....	Retained on 1/4-inch sieve. 10%.
12	2+	40	.....	Traces of CaCO ₃ .	Sub-angular.	0	60	22	.....	Only 2 upper feet seen in several test pits. 2 to 3 feet in depth. Many shells seen in the holes. Over 80% of Black River limestone. Medium coarse gravel, fairly regular in size. Matrix of fine sand and silt in the upper 2 feet. Coarse gravel.
										Estimated made from what seen in two test pits on top of ridge; the test pits are 2 feet deep. (Over 2 feet) of Black River limestone, rather soft in the upper 2 feet. Coarse gravel.
										Estimated made from what seen in several test pits. 2 to 3 feet in depth. Many shells seen in the holes. Over 80% of Black River limestone. Medium coarse gravel, fairly regular in size. Matrix of fine sand and silt in the upper 2 feet. Coarse gravel.
										Estimated made from what seen in several test pits. 2 to 3 feet in depth. Many shells seen in the holes. Over 80% of Black River limestone. Medium coarse gravel, fairly regular in size. Matrix of fine sand and silt in the upper 2 feet. Coarse gravel.
										Estimated made in the north bank, where uncovered to a depth of 2 feet. No stratification observed. Pebbles are largely Chazy and Black River limestone.

13	2 to 2.5	25	32	38 (Traces of CaCO_3)	Sub-angular	1	35	31
14					Sub-angular			
15	3+	30	45	25	Traces of CaCO_3 ; Sub-angular; Dirty gravel. Roots all through.	1	48	51
16	11+	25	55	20	Sub-angular and flat angular.	0	36	44
17	11+				Many traces of Sub-angular FeO_3 .			
18	4	40	30	30	A little FeO_3 and Angular to sub-angular.	5	10	35
19					Sub-angular	0	70	30
20	4+				Moderate amount CaCO_3 (weathered part).	2	65	33
21	2+	50			Traces of CaCO_3 .			
22	1 to 11	5	67	28	Some CaCO_3 .	3	30	47

Charlottesville Townships—(Continued).

Map No.	Depth of Weathering (in ft.)	Percentage		Impurities CaCO ₃ , FeO _x , Clay, etc.	Shape of Pebbles	Percentage			Remarks
		Boulders over 3 in	Gravel 1 to 3 in			Dur	Int	Soft	
23	.....	.....	.....	.....	Sub-angular	5	23	70	Mechanical analysis - Retained on 3 mesh sieve. 70% - 5% 7.5 - 20% 5.0 - 45% 3.0 Plastic 45% 1.5 Sample tested.
24	3	17	40	33 A little CaCO ₃ and FeO _x .	Sub-angular	2	26	72	No gravel seen on surface, probably on account of the poor weathered part. Pebbles are in order of decreasing proportion, Black River limestone, Beckinston & limonite, Portman, Rochester, Chazy sandstone and shale. Mechanical analysis - Retained on 3 mesh sieve 50-60% - 5% 11.5 - 20% 10.5 - 45% 6.5 Plastic 45% 0.5 Sample tested.
25	.....	.....	.....	.....	Sub-angular	.....	.....	.....	No gravel seen on surface, probably on account of the poor weathered part. Pebbles are in order of decreasing proportion, Black River limestone, Beckinston & limonite, Portman, Rochester, Chazy sandstone and shale. Mechanical analysis - Retained on 3 mesh sieve 50-60% - 5% 11.5 - 20% 10.5 - 45% 6.5 Plastic 45% 0.5 Sample tested.
26	2	50	40	10 Traces of FeO _x Mod. rate amount of CaCO ₃	Sub-angular	1	41	58	Mechanical analysis - Retained on 3 mesh sieve. 50-60% - 5% 7.5 - 20% 5.0 - 45% 2.5 Plastic 45% 1.5 Sample tested.

27	2 to 2½	70	16	14	Angular to sub-angular to sub-angular. Some CaCO_3 .		21	87	49	Pit wall stands up well. Face 9 feet deep in north east part of pit. It shows thin bedded gravel with low percentage of sand. Some talus tested. Above 30' of the pit壁 is talus.
										Stratigraphic analysis—
										Retained on 3 mesh sieve. 32.5%.
										18
										12
										4
										20
										1
										30
										1
										40
										1
										2.5
										Estimation made on weathered part, on a depth of 2 feet. Face talus-covered. The talus is very uneven, all around, except in the north east where old road and talus are even. No stratification seen. The gravels are largely Black River boulders, the remainder being mainly Potomac and Cherry materials.
										Road cut 1 foot deep. Very bouldery gravel. Over 80% of gravel, small proportion being shales.
										Trotton, thin layer of talus, being shales.
										Estimation made along the west slope of a ridge, made in 3 ft of bank, south end, the lower part being talus-covered. Large, more bouldery in other parts of pit, but only the top of bank could be seen. Several shales.
										Top of bank, talus-covered, talus.
										Trotton limestone.
										Stratigraphic analysis—
										Retained on 3 mesh sieve. 30%.
										18
										12
										4
										20
										1
										30
										1
										5
										Sample tested.
										Small pit 5 ft face in north bank. Very thin, clear stratified gravel, with many shales, mostly talus-covered, made to the surface, small talus tested.
										Stratified gravel. Very large number of shales. Pebbles are mostly limestone.
										No pit opened, and surface indications are rather talus, rather coarse gravel. Deposits covered with clear bank.

Cornwall Township—Continued.

Map No.	Depth of Weathering (in feet).	Boulders over 3 in.	Percentage.		Impurities.	Shape of Pebbles.	Dur.	Int.	Soft.	Percentage.	Remarks.
			Gravel 1 to 3 in.	Sand under 1 in. CaCO_3 , Fe_2O_3 , Clay, etc.							
35	2 to 3	60	.....	Large amount of clay. Traces of CaCO_3 .	Angular.....	.....	.....	.....	.....	.....	Pit walls talus-covered. Small amount of gravel; pebbles are mostly Black River limestone. Apparently a boulder clay deposit.
36			.....	.....	Angular.....	.....	.....	.....	.....	.....	The gravel deposit forms part of a long boulder clay ridge. There is no pit opened, and judging from surface indications, it might possibly be all boulder clay, being a little more gravelly than the rest of the ridge. Limestone boulders of the Black River type, scattered over the surface.
37	3	14	42	44	Much clay and Sub-angular. CaCO_3.	.....	.....	.....	.....	.....	Depth of bank 7 feet; estimates made on lower 4 feet. Large amount of shells. Stratification well shown.
.....	2	40	11	25	Some CaCO_3	Sub-angular.....	.....	.....	.....	.....	b—Southeast bank. Uncovered depth of bank 64 feet. Lower 34 feet very bouldery. Some marine shells. Stratification visible but not well marked.
.....	.....	.....	.....	.....	Sub-angular.....	.....	.....	.....	.....	.....	c—West bank. No stratification seen. Some shells. Over 50% of Pebbles in Black River limestone, the remainder being Potash sandstone, Chazy shales and weathered stones. East bank more bouldery than other parts. The pit walls stand up well. Samples tested from a and b parts of the pit.
38	2	III	30	60	A little CaCO_3	Angular to sub-angular.	3	60	37	.....	Estimates made in the northeast bank. Sand only is seen in the other pits faces. The pebbles are largely limestone and dolomite, the latter being in much smaller amount. A few shells in the bank.
39	4	15	40	20	Traces of CaCO_3 .	Sub-angular.....	.....	.....	.....	.....	Pit on the east slope and near top of a small West bank; all boulder clay and silt. In north bank a streak of gravel, 4 feet thick, runs through boulder clay and silt. Estimates refer to gravel streak only. Pebbles are largely Trenton limestone.
40	3	15	55	30	A little CaCO_3	Sub-angular.....	.....	.....	.....	.....	No stratification seen. Pebbles are limestone for the largest part; Trenton, Black River and Chazy.

41	4	15	55	30	Large amount of Angular CaCO ₃ .	Sub-angular	3	49	48	Bottom of pit almost covered with boulders. Estimates made in the upper 31 feet of the face, and in weathered part. No clean face seen farther down. Estimates made in two different places. No stratification seen. The pebbles are largely Black River and Chazy limestones, the former being predominant. Sample tested.
42	4	30	33	37	A little CaCO ₃ and Sub-angular clay.	Sub-angular	5	25	70	Railroad cut 30 feet in depth; the upper part only is not talus-covered. Apparently unstratified.
43	1½ to 2	5	60	35	Traces of FeO ₃ , some pebbles coated with CaCO ₃	Sub-angular	3	69	28	No boulders over 5 inches in size. Finer gravel toward the bottom. Estimates made in west bank, uncovered to a depth of from 4 to 5 feet, the wall standing up well. Pit walls talus- covered everywhere else. No stratification seen. Many small shells in gravel, sand is bluish- grey. Mechanical analysis:—
							Retained on 3 mesh sieve ..00-0'75			
							" 8 " "			
							" 20 " "			
							" 44 " "			
							" 48 " "			
							Passing 48 "			
							" 48 "			
										Pebbles are mostly limestone. Sample tested.
44	2 to 3	2	63	35		Sub-angular	...	...	...
45	2	20	55	25	Traces of CaCO ₃	Sub-angular	5	59	36	Pit walls talus-covered. Estimates made in 1 foot of bank seen at only one place in the pit. None shells.
46	4	20	45	25	Traces of CaCO ₃ , a little FeO ₃ ,	Sub-angular	5	71	24	5-foot face above coarse, stratified gravel. Pebbles mostly Trenton.
	3	23	56	20	Some CaCO ₃ .	Sub-angular	4	78	18	b—North bank. 6½-foot face. Coarse stratified gravel. Several shells. Over 85% of pebbles is limestone, largely Trenton. Mechanical analysis:—
							Retained on 3 mesh sieve ..00-0'75			
							" 8 " "			
							" 20 " "			
							" 44 " "			
							Passing 44 "			
							" 48 "			
										Pit walls stand up well. Pit on west slope and near top of gravel ridge. Samples tested.
47						Rounded and sub- angular	...	...	...	No pit opened. Estimates made from surface in- dications and from woodchuck hole. Fine gravel; over 75% of the pebbles is Trenton limestone.

Cornwall Township—(Continued).

Map No.	Depth of Wash. (in ft.)	Percentage.		Impurities.	Shape of Pebbles.	Dur.	Int.	Soft.	Percentage.	Remarks.
		Boulders over 3 in.	Gravel 1 to 3 in.							
48	...	2	...	Sand Over 50	CaCO ₃ , FeO ₂ , Clay, etc.	...	...	...	...	Small pit on top of hill; 2-foot face shows a fine stratified gravel with much sand and large number of shells. Pebbles are largely limestone. At southwest end of deposit, coarse gravel and coarse sand seen in bottom of ditches, under 1½ to 2 feet of loam (swampy soil).
49	1½	15	61	24	Some CaCO ₃	Flat rounded and sub-angular, more angular in west bank.	0	77	23	Pit near top of a ridge running east-west. The upper 3 feet of east bank show a coarse, stratified gravel, voids being only partially filled with a fine, sandy sand. Second size estimates refer to west bank, 200 yards from east bank. Stratification not well shown in west bank. Over 95% of pebbles is Trenton limestone, part being shaly. Sample tested. Mechanical analysis:—
		20	60	20						Retained on 3 mesh sieve 71.3 %
										8 " " 15.0 "
										20 " " 7.5 "
										48 " " 2.8 "
										48 " " 2.8 "
50	3½	15	60	25	Traces of FeO ₂ .	Angular.....	...	...	...	—
	2	10	65	25	A little FeO ₂	Angular and sub-angular.....	1	81	18	Uncovered; 7 ft. of stratified, coarse, clean gravel. Many shells.
										b—North bank.
										Uncovered; 5½ ft., coarse stratified gravel. Several small shells, 90% of pebbles is limestone, largely Black River; some Trenton.
										c—East bank, 200 ft. south of (c) is closer to crest of ridge than (a). Uncovered; 5 ft. Very bouldery, stratified gravel. Large number of shells in the upper part.
										d—South bank, 300 ft. from north bank. 1 ft. of face seen. Fine, stratified gravel, with large amount of sand and some silt. Large number of shells in the upper part; several shells seen down to the bottom. Over 90% of pebbles is limestone. Mechanical analysis:—
										Retained on 3 mesh sieve 58.0 %
										8 " " 13.5 "
										20 " " 8.8 "
										48 " " 16.2 "
										48 " " 7.5 "
										Panning

Onabruck Township.

77498-4

Osnabrück Township—(Continued).

Map No.	Depth of Weather. in (ft.)	Percentage.		Shape of Pebbles.	Impurities.	Percentage.	Dur.	Int.	Silt.	Remarks.
		Boulders over 3 in.	Gravel 1 to 3 in.							
55	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
56	1 to 21	40	40	Sub-angular	Lens of clay, a little Fe ₂ O ₃ , much CaCO ₃ .	3	65	32	Retained on 3 mesh sieve 52.5 %	Pit dug on top of ridge 15 ft. face in east bank—9 ft. of very coarse and bouldery gravel over 6 ft. of fine, stratified gravel and sand with a few boulders. A few feet east, a pit shows boulder sand with a very high amount of boulders, and 25 ft. west in the west slope of the ridge, the gravel is fine and stratified, mixed with high amount of sand and some shells. 80% of the pebbles in Black River limestone. Pit walls stand up well. Mechanical analysis:—
57	44	40	30	Angular and sub-angular	A little CaCO ₃	3	86	11	Retained on 3 mesh sieve... 67.5%	Pit on top of small ridge. South bank shows 10-11 ft. lower 4 ft. being talus-covered. Very bouldery gravel. Stratification not well marked. Fine stratified gravel in the upper 2 ft. Over 90% of pebbles is Trenton limestone.
58	.....	.....	.....	Angular	.....	.....	.....	.....	.....	Old pit, bank all covered with talus. Several shells seen in talus. Coarse gravel with much sand; pebbles are largely Trenton limestone.
59	5	35	40	Angular	Traces of Fe ₂ O ₃	2	82	16	.....	Pit dug on top of small ridge, walls mostly talus-covered. Estimates made on 2½ foot face, below top of east bank. A few broken shells in the bank. Much variation as to size. Parts of sections seen in west bank reveal as high as 50% of boulders. Over 80% of the pebbles is limestone, largely Trenton.

60	1 to 2	10	40	50	Traces of CaCO_3 . Same FeO_3 .	Sub-angular.....	4	79	17	Ditch cut, showing 3-foot face. Fine, stratified gravel with much sand and a few shells. Over 80% of the pebbles is limestone, largely Trenton. The cut is in the lower part of west slope of ridge.
61	.....	.....	.....	.....	.....	Sub-angular.....	.....	.....	.....	Small pit on top of a flat ridge; 5-foot face seen in south bank; walls talus-covered everywhere else. The pebbles is limestone, Trenton and Black River.
62	13	30	40	30	Traces of CaCO_3 . Traces of FeO_3 .	Sub-angular.....	0	71	20	Pit on top of a flat ridge; 5-foot face seen in south bank; walls talus-covered everywhere else. The pebbles is limestone, Trenton and Black River.
63	2 to 3	20	50	30	A little FeO_3 .	Angular.....	0	40	40	7-foot face. Coarse and bouldery, stratified gravel; carrying a large number of shells. Over 90% of the pebbles is limestone, Black River and Trenton.
										Mechanical analysis:—
							Retained on 3 mesh sieve... 80%			
							" " 8 "	0		
							" " 20 "	0		
							" " 48 "	10		
							" " 18 "	18		
							" " 4 "	4		
							Passing			
										6—East bank 250 ft. from north end.
										Charee and bouldery, stratified gravel;
										carrying a large number of shells. Over 90% of
										The pebbles is limestone, Black River and
										Trenton.
										7—East bank, 100 ft. south of e.
										7-foot face. Very bouldery, stratified gravel; colonies of shells to a depth of 13 feet. 43 feet below top, same coarseness as in e.
										c—East bank, near south end.
										9-foot face. Very bouldery, stratified gravel; a few shells.
										Stratification better shown in the lower parts of West bank, th., gravel being less bouldery.
										West bank, where seen, shows a little gravel and a high amount of sand, all well stratified; large number of shells.
										Samples tested. (See Plate IV).
24 to 34	50	35	15	Traces of FeO_3 .	Angular.....	.....	.....	.....	.....	Old pit; walls talus-covered. Estimates made from surface indications and from two woodcheck holes. Bouldery gravel on top. Pebbles are largely Trenton limestone; some Black River.
2 to 3	30	20	20	Traces of FeO_3 .	Angular.....	.....	.....	.....	.....	Large shallow pit on west slope of flat hill, 2 yds in height. 3-foot face seen in north bank. Stratified. Several shells. A little coarser in east and south banks. Over 80% of the pebbles is limestone.
64	.....	.....	.....	.....	Angular and flat.	.....	.....	.....	.....	(Old pit; bank all covered with talus, except the upper foot; average depth of pit, 1 yd. Looks much the same as No. 65.)
65	24	15	45	40	Traces of FeO_3 .	Sub-angular.....	7	69	24	.....
66	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....

Onabrück Township—(Continued.)

Map No.	Depth of Weather. (in feet.)	Percentage.		Impurities.	Shape of Pebbles.	Percentage.			Remarks.
		Boulders over 3 in.	Gravel 1 to 3 in.			Dur.	Int.	Sft.	
67	.....	20	.....	Sand CaCO ₃ , FeO ₃ , Clay, etc.	Sub-angular...	.....	.....	.....	Old pit; 1-foot face seen at one place. Stratified gravel. Many broken shells. Over 85% of the pebbles is limestone; Black River and Trenton.
68	1½ to 2	30	50	Traces of FeO ₃ ...	Angular to sub- angular.	0	50	50	Small pit; 3 feet deep. Gravel uniform in size. Unstratified. Pebbles are largely limestone.

Williamsburg Township.

69	1½	5	50	45	Traces of FeO ₃ ...	Sub-angular...	2	87	11	Old pit; 2½-foot face seen in northeast bank. Stratified gravel. Over 85% of the pebbles is Trenton limestone. Pebbles largely limestone.
70	1½	1	19	80	A little clay and FeO ₃ .	Sub-angular...	.....	.....	.....	Small pit; 3 feet deep. Stratification not well shown. Pebbles largely limestone.
71	2	1	50	40	.....	Sub-angular...	2	80	9	Pit walls also-covered, except in west bank, where there is a 2-foot face. Fine, stratified gravel, with high amount of sand, and many shells. Trenton limestone; 30% Black River limestone.
72	.....	.....	.....	.....	.....	.....	.....	.....	.....	Old pit; very little gravel seen; apparently nearly all worked out. Pebbles are largely limestone.
73	.....	.....	.....	.....	.....	Sub-angular...	7	67	26	Three old pits; pit walls also-covered. Estimates made from surface indications. Coarse gravel. Over 80% of limestone; Black River and Trenton.
74	3	10	45	45	Traces of FeO ₃ ...	Sub-angular...	.....	.....	.....	Four-foot face seen in east bank. Fine, gravel; much sand, not well stratified; a few shells. Pebbles are mostly Black River limestone, generally soft.
75	2½ to 3½	15	40	45	Traces of clay...	Sub-angular...	1	64	35	Four-foot face. Coarse, stratified gravel with silt and loam in the upper part, and much sand with several shells in the lower part. 80% of the pebbles is limestone.

e—North bank.

.....

				Trace of FeO ₂	Sub-angular...
75	3	25	40	35	
76					Sub-angular and flat
77		25			Sub-angular and angular
78					Sub-angular
79	2 to 3½	25	47	23	Some CaCO ₃ ... Organic matter.
80	2½	10	60	30	Some CaCO ₃ ... Organic matter.
	2 to 4	30	45	25	Some CaCO ₃ ... Organic matter.

b—East bank
4½-foot face. Very coarse, stratified gravel with much sand and several shells.
Mechanical analysis.—
Retained on 2-mesh sieve... 63-5%
" " 8 " " 13-5
" " 20 " " 13-5
" " 45 " " 16-5
Passing 45 " " 3-1
Pit on top and west slope of a ridge. Pit walls stand up well. Sample tested.

Old pit on top of ridge; pit walls talus-covered. Pebbles are largely black River limestone, part being soft and ably.

No pit. Estimates from surface indications and small hole 1 foot deep on top of ridge. Probably very bouldery gravel. Over 50% of pebbles are limestone.

No pit. Medium coarse gravel seen at foot of fence posts near brick house and above the crest of a ridge. Many large igneous boulders on both slopes of the ridge.

Pit cutting through the top of a ridge 5-foot face in north bank. Bouldery stratified gravel Uniform in size all around the pit. 70% of the pebbles is limestone; more than half being soft.

Mechanical analysis.—
Retained on 2-mesh sieve 50-6%
" " 8 " 15-1
" " 20 " 3-9
" " 45 " 20-2
Passing 45 " 1-3
Sample tested.

c—South bank.
3½-foot section, 3 ft. being talus-covered. Medium coarse, stratified gravel, with very large number of shells. Over 90% of the pebbles is limestone.
Mechanical analysis.—
Retained on 2-mesh sieve 65-0%
" " 8 " 17-5
" " 20 " 12-5
" " 45 " 2-7
" " 48 " 1-3
Passing 48 " 1-3
Pit cutting "South bank, east of section c. Generally 10-foot face, 1 ft. being talus-covered. Generally coarse, stratified gravel, with very large number of shells found to a depth of 8 feet. Pit cutting through top and west slope of a ridge. Pit walls stand up well. Sample tested.

Williamsburg Township—(Continued).

Map No.	Depth of Weathering (in feet).	Percentage.			Impurities.	Shape of Pebbles.	Percentage.			Remarks.
		Boulders over 3 in.	Gravel 1 to 3 in.	Sand under 1 in.			Dur.	Int.	Sof.	
81	A little clay.	CaCO ₃ , FeO ₂ , Clay.	Sub-angular.	.....	.....	.....	Old road cut, talus-covered. Estimates made from surface indications and from two woodchuck holes. Very coarse gravel. High amount of fresh limestone pebbles.
82	10	60	30	.....	Sub-angular.	.....	.....	.....	Gravel seen in the bottom of creek. It is said that about 100 cu. yds are carried there by the creek every spring. About 90% of the pebbles is limestone.

Matilda Township.

83	1½ to 3	70	18	12	Traces of FeO ₂ .	Sub-angular.	6	36	58	Pit or top of a ridge. 4-foot face seen in south bank. V. v. bouldery gravel or boulder sand. Pit walls stand up well. 90% of the pebbles is dolomite and limestone. Samples tested.
84	1½	25	60	25	Traces of FeO ₂ .	Sub-angular.	2	58	40	Pit walls talus-covered. Estimates made on a 2½-foot face in a small hole, bottom of pit 4 feet from top of bank. 90% of the pebbles is dolomite and limestone.
85	1½ to 2	23	47	26	Much CaCO ₃ .	Sub-angular.	6	50	44	South bank shows 5½-foot face. Pit walls stand up well. Over 90% of the pebbles is limestone and dolomite. Mechanical analysis — Retained on 3 mesh sieve 82.3%.
										2 " 8 "
										20 " 15.0
										48 " 16.0
										48 " 5.3
										Panning. 48 " 1.3
										Stampings tested.
86	6	60	25	15	Some clay.	Sub-angular.	0	64	36	Pit on top and west slope of a ridge. 10-foot section in north bank. 1 foot being talus-covered. Very bouldery, unstratified gravel. A few shells. Low bouldery in northwest and northeast parts. Over 80% of the pebbles is limestone. Pit walls stand up well.

Edwardsburg Township.

91	.....	.....	.....	Sub-angular	16	48	36	Pit walls talus-covered. Pit on west slope of a ridge. Looks rather like boulder bed. No stratification seen. Dor.—Granite, granite-granite. Im.—Bentonite.
92	2 to 2½	5	70	Traces of Fe ₂ O ₃	Sub-angular	4	55	41 Estimates made in southeast bank, 111 feet on ridge, 5 ft. being talus-covered. Stratified gravel, uniform in size. 45% of the pebbles is dolomite, some limestone. Pit walls stand up well. In north bank corner, unstratified gravel. Sample tested. (See Plate V).

APPENDIX IV.
Commercial Development.
Lancaster Township.

Map No.	Location.	Owner and Address.	Amount Excavated (in cu yds.)	Use.	Amount Available.	Remarks.
1	Con. II, lots 8, 9	Archie Currie, Bassville P.O.	104	Used on roads	Well dug 9 feet deep. Gravel overbedded—15 in. Bedrock still found at that depth but coarser than on top. The gravel only 10 inches thick. The deposit forms a rounded ridge, covering an area of 25 acres.	Dredging good. Deposit above Grand Trunk Railway main line. Heading distance to front road 1 mile by land and 2 miles by side road.
2	Con. I, lot 12	George Helps, Rumville P.O.	None		The deposit forms a flat ridge, covering an area of 20 acres.	Dredging good. Deposit above Grand Trunk Railway main line. Heading distance to front road 1 mile by land and 2 miles by side road.
3	Con. IV, lot 23	John McCabe, Bainbridge R.H.I.	121	Used for concrete. One neighbour made a concrete cedar Proportion: one cement, 6 gravel—1 month old concrete very poor.	Well dug by owner on deposit 65 feet deep; 40 feet of rock or clay similar to that in the pit, and 19 feet of rock. The deposit covers an area of 8 acres.	Overbedding 12 Good dredging. Deposit above Grand Trunk Railway main line. Heading distance to front road.
4	Con. II, lot 28	D. C. Morris, Lancaster P.O.	12	Used to repair the road in Con. II.	Depth of pit, 1 yard. The pit situated on a small flat hill. The deposit occupies an area of 14 acres.	Overbedding 2 feet of limestone. Head of 2 miles to front road.
5	Con. I, lot 36	D. M. McCusick, Lancaster P.O.	4,585	Used to repair roads for many years. For concrete walls in Lancaster and other concrete works.	Depth of pit 7 feet. The deposit forms a flat ridge, a few feet above flat, and covers an area of 9 acres.	Dredging good. Overbedding 2 to 3 feet. Limestone developed much more easily to thicknesses of overbedding. Gravel only 10 inches thick. Depth, 1 mile from front road.

6 Con. I, lot 36.	D. M. McCraig, Lancaster, P.O.	107	To repair roads Depth of pit 4 feet. Very small Gravel drainage. (Overburden deposit.) 1 foot. Deposited 1 mile from front road.
7 Con. I, lot 36	John Shanks, Lancaster, P.O.	1900	Recently used in place of road between pit and Lancaster. Good condition where suffi- ciently rolled by traffic.

Charlottenburg Township.

8 Con. V, lot 55.....	John Keir, Williamstown, R.R.	2,500	Used for making concrete. The owner made a concrete floor for stable - 1 year old. Satisfactory condition. Portion, 1 cement, 6 gravel. Used on slopes on the road nearly. The parts recently gravelled are in poor con- dition, due mostly to the soft underlying soil. Plats 2 inches deep all alone. Too coarse gravel used, resulting in a rough surface.	At the pit, clay found 10 feet (Dredging). Dredges under bottom of pit. 9 feet from top of ridge (from owner's information). Could be easily dredged down the ridge. Gravel only 10 cents a bushel. Gravel and 25 cents a foot taken in the back. One barrel, 9 to 12 inches Gravel, and many small stones. The ridge is made of a mixture of a coarse clay or sand hill. The whole is stony or loose gravelly surface. Half of 41 miles to front road and two miles to railway siding.	Good drainage. Gravel under 25 cts a bushel. A bushel of gravel comes from the ridge above the road, and 5 cents a foot. Half of 14 miles to the front road and 11 miles to railway siding.	Good drainage. The deposit is the same as No. 9.
9 Con. V, lot 52.....	O. McPherson, Williamstown, P.O.	Over 1,000	Largely used to repair bad spots on main road leading to Williamstown. The gravel- led parts have a very un- stable surface. Rough and uneven where recently gra- velled. Very few traces of gravel in some parts.	The deposit forms a flat ridge on the west slope or top of a boulder hill. The hundred yards east of the mapped gravel area, clay was found under 18 inches of gravel The deposit extends over an area of 20 acres.	The C.P.R. Co. is said to have dug several tons per 5 feet deep and found gravel all through but did not buy any on account of the cost of the deposit.	The C.P.R. Co. is said to have dug several tons per 5 feet deep and found gravel all through but did not buy any on account of the cost of the deposit.
10 Con. V, lot 52.....	J. A. McDonald, Jr., Williams- town, P.O.	80	Used to repair parts of road now covered with broken stone.	None.	None.	
11 Con. IV, lot 5.....					Good drainage. (Overburden only 2 to 3 yards above the flat, probably the amount available is very small. The deposit covers an area of 4 acres.	

Charlottenburg Township—(Continued).

Map No.	Location.	Owner and Address.	Annual Excavated in cu. yds.	Units.	Amount Available.	Remarks
12	Con. III, lot 4	Alex. Sherish, Summersettown Sta., R.R. I.	56	Used to gravel 1,000 feet of the side road north, at the south foot of the ridge, about 300 feet north of the C.R.R. track. The material is a soft clay in a highly drained area. (Four of pit sand bags were put in the bottom and 9 to 10 inches of gravel on top; 7 to 8 feet wide. Work done in June, 1917. Many bags ruined and rate 1 to 11 inch deep all along. Weathered and unweathered gravel and overburden included. Very light traffic.	Gravel wells 6 to 12 inches above the surface. Several boulders up to 3 feet in size were found. So-called cut line between the two. The deposit lies over an area of 45 acres.	25 ft. x 12 ft. x 12 ft. 6 in. 12 ft. 6 in. x 12 ft. 6 in. 12 ft. 6 in. x 12 ft. 6 in.
13	Con. III, lots 4, 5.	Charlottenburg township council.	154	Used to gravel 1/2 mile of road in the east end of the town.	Gravel wells 12 ft. 6 in. x 12 ft. 6 in.	25 ft. x 12 ft. 6 in.
14	Con. III, lot 8.	Unknown, main road, main road, main road.	1,600	Used to gravel 1/2 mile of road above a small clay hill; no cut line between the gravel and the boulder clay.	Gravel drainage. Hasling the amount of 4 miles to the front road.	25 ft. x 12 ft. 6 in.
15	Con. II, lot 12.	A few.	Unknown, ridge rising to a height of 2 rods above a boulder clay hill; no cut line between the gravel and the boulder clay.	The deposit extends over an area of 5 acres.	25 ft. x 12 ft. 6 in.	
16	Con. II, lot 9.	J. Hand, Summersettown Sta., R.R. I.	4	Used in lawns.	Small ridge, rising to heights of 2 rods and 21 years above a boulder clay hill; soil occurs in 3 inches gravelly loam. Haul of 21 yards to front road.	25 ft. x 12 ft. 6 in.

17	Cou. II, lot 9.....	Charlottesville township comm. cl.	1.100	Used a few years ago to repair Flat hill ridge to height of 2 feet. Spots in the road in front and side road east of the deposit. Very few areas of gravel were on the road. The surface of the ridge is fairly even, but has no crown. Sandy loam soil.	2	Overburden: 6 inches of loam to 3 feet above the flat, and 1 foot to 2 miles to the front ridge.
18	Cou. I, lots 1, 2.....	A. J. Fraser, Summersettown Station, R. R. 1.	2.12	Used on private road; 25 loads. The mapped deposit covers one-half mile on east road nearly used on east road nearly repair road spots. Marshy subsoil Road well graded and surface in fair condition during dry seasons. Main- tained by drainage.	3	Overburden: 6 inches of loam to 3 feet above the flat, and 1 foot to 2 miles to the front ridge.
19	Cou. I, lots 9, 10	H. A. Creek, and C. McDo- nald, Summersettown, P.O.	2.13	The deposit is mapped in ridges probably more than circular clay than gravel.	3	Many boulders scattered over the surface. The deposit is within one-half mile of the front road, and 1 miles from the river.
20	Cou. IV, lot 19		2.14	A few.	23	Small gravelly areas in the overburden: over a number of highest part of a boulder clay ridge. The outlines of the gravel areas are not well defined.
21	Cou. III, lot 23	Alex. A. McDogall, Williams- town, R. R. 1	2.15	Used by owner for making concrete blocks, 14 yrs. old, blocks in good condition. Preparation removal of gravel. Boulders taken out.	2	Small gravelly ridge on the Canal drainage, depth 25 ft. a load (overburden) to 15 inches of sandy loam with boulders. Grading distance of 1½ miles to the front road.
22	Cou. II, lots 23, 24.....	T. Doherty, Summersettown, R. R.	2.16	Used for a concrete stable floor. The deposit forms a small gravelly rounded ridge on top of a much larger boulder clay or mud ridge. The gravel deposit extends over an area of 23 acres, but there is sharp outline between the gravel and the boulder clay. Well classed for use on top of deposit, and gravel will form at that depth.	9	Overburden: 6 inches of loam to 3 feet above the flat, and 1 foot to 2 miles to the front ridge.

Charlottenburg Township—(Continued).

Map No.	Location.	Owner and Address.	Amount Excavated (in cu. yds.)	Uses.	Amount Available.	Remarks.
23	Con. II, west end of tp.	Allan Lossay, Cornwall, R.R. 1	None	The deposit lies on top of a wide boulder clay hill, and occupies an area of 19 acres.	Drainage good. Hauling distance of 2 miles to the front road.	
24	Con. II, west end of tp.	D. Richardson and L. Leroux, Cornwall, R.R. 1.	156	Used in 1914 on last one-half mile of front road, west end of township. Very bad condition, much clay on surface. Clay subsoil. Used for concrete.	The deposit forms a flat ridge extending over an area of 91 acres; it probably includes much boulder clay.	Overburden: 1 foot. Drainage good. Gravel sells 50 cts. a foot. Hauling distance of $\frac{3}{4}$ miles to the front road.
25	Con. IV, west end of tp.		None		Small ridge on a wide boulder clay hill; very few indications of gravel on the ridge, which covers an area of about 6 acres; the amount of gravel is uncertain.	Large number of limestone boulders scattered all over the surface of the deposit. Hauling distance to front road: 4½ miles (through bed roads).

Cornwall Township.

26	Con. III, lot 7.....	Dan McCabe, Cornwall, R.R. 2.	10	For roads and concrete.....	Small pit on north slope of same ridge as No. 27.	Drainage good. Overburden: 1 to 2 feet. Loan. Gravel sells 25 cts. a load. Same hauls as for No. 27.
27	Con. II, lots 7, 8.....	Manager: C. L. Moeggen, Cornwall P.O.	10,000	Run of the bank used to gravel roads and some streets in Cornwall. None is fair condition. Crushed boulders used for fronting roads and streets in Cornwall. Stoned roads are in good condition in places, but streets are generally in bad state. Screened gravel used for concrete. Pumphouse in Cornwall made of concrete. Proportion: 1 cement, 3 screened gravel.	The gravelly parts form a ridge running approximately north-south, on top of a much wider boulder clay or sand hill. The ridge covers an area of 26 acres, but no sharp outline between the gravel and boulder clay or sand ridge from surface indications. The gravel is said to be 12 feet deep.	The gravelly parts form a ridge running approximately north-south, on top of a much wider boulder clay or sand hill. The ridge covers an area of 26 acres, but no sharp outline between the gravel and boulder clay or sand ridge from surface indications. The gravel is said to be 12 feet deep.

	Unknown; probably used long time ago on road nearby, now surfaced with broken stone. Fair condition	The deposit as mapped covers Overburden: 18 inches. Drainage good. West face of pit has reached limit of deposit; to the east the deposit is not promising, being too bouldery. Haul of 4½ miles to front road and canal, and 3½ miles to railway siding.
29	Con. IV, lot 11 William J. Robertson, Millie Rueben, R.R. 1.	115 Said to have been all used by township council to put in a hard place on concession road nearby. This was gravelled several years ago. Some gravel seen on that part of road, but the road is in bad condition owing chiefly to softness of subsoil (swamp)
30	Con. IV, lot 10	None
31	Con. V, lot 11 Father McRae, St. Andrews West P.O.	2,979 Used by the township council to gravel roads many years ago. The roads have been since stoned with broken stone, and are in satisfactory condition.
32	Con. V, lot 12.....	John McIntosh, St. Andrews West P.O.
33	Con. V, lot 12.....	John McIntosh, St. Andrews West P.O.

Cornwall Township—(Continued).

Map No.	Location.	Owners and Addresses.	Amount Excavated (in cu. yds.)	Uses.	Amount Available.	Remarks.
24	Coa. IV, lot 15	John Pierce, Mille Roches P.O.	None			Dredging good. Haul of 4 miles to front road, canal and railway siding.
35	Coa. III, lot 20	Levi Groves, Mille Roches, R. R. I.	33	To repair roads and for concrete. Stable floor made 4 years ago. Proportion: 1 cement, 8 gravel. Surface not sealed.		The mapped deposit occupies an area of 3½ acres, but being covered with boulders, surface indications furnish very little information as to the extent of the deposit, so the amount available is uncertain.
26	Coa. IV, lots 25, 26	John Manson, Mille Roches, P.O.	None			Small ridge of boulder clay and gravel, 6 acres in extent, at the east end of a larger boulder clay ridge. A stone pit at depth of 8 feet, boulder clay only is found.
27	Coa. IV, lot 29	Thomas Cleary, Mille Roches P.O.	3,825	Used on King's road and front road, east of Mille Roches. For concrete.		Flat gravelly ridge extending over an area of 30 acres. May possibly include much boulder clay.
33	Coa. V, lot 30	Jay Moon, Mille Roches P.O.	667	Used by owner for concrete		The deposit occupies the western slope of a boulder clay hill and covers an area of 22 acres.
30	Coa. V, lot 39	C. H. Wood, Moulinette P.O.	544	Used four years ago for concrete at foot of canal bank at Moulinette.		(1) Overburden: 10 inches. Drainage good. Gravel soils 25 ft. a load. Deposit close to front road and canal, and three-fourths of a mile from railway siding.
						(2) Overburden: 1 foot. Drainage good. Very large number of limestone boulders along eastern edge of deposit, and farther east. Haul of 1½ miles to front road, canal and railway siding.
						Good drainage. Gravel soils 20 cts. a load. (Overburden: 9 to 12 inches. Silty loam soil clay was found in pit at a depth of 15 feet. Amount available uncertain and probably very small, on account of large proportion of boulder clay.)

The deposit as mapped includes small boulder clay; patches from surface indications only. Small areas in the north and west parts are real gravel. At pit 40 the deposit has the shape of a ridge running along the west edge of the boulder clay hill.

Used a few years ago for roads and concrete.

2,963

Overburden: 8 inches. Drainage good. Gravel sells 25 cts. a load. Hauling distance of 2 miles to front road, canal, and railway siding.

41 Con. V, lot 27

Alex. Day, Moulinette P.O.

2,778

Same uses as for No. 40.

42 Con. V, lot 23

J. F. Ruzion, Mille Roches P.O.

278

Used for railroad embankment by the New York Central company.

43 Con. V, lot 22

H. Winter, Mille Roches R.R.

9,240

Used for many years to repair roads in vicinity of 2,000' elevation, used by the Public Works Dept. for a concrete pier at Moulinette.

44 Con. V, lot 19

Cyril Neck, Mille Roches, R.R.I.

300

To repair roads and for concrete.

45 Con. VI, lots 23, 24

J. H. Beattie, Harrison, R.R.I.

3,867

Used by people to gravel side road nearby and road along Pains River. Both in generally good condition but, duty (dry weather). Small ruts all along. Where recently gravelled, the stone is all loose. No rolling done.

(Overburden: 6 inches. Drainage good. Gravel sells 25 cts. a load; seeds zeroing. Same haul as for No. 40.

Small knoll on top of a boulder clay hill. Greatest depth of gravel in pit, 15 feet.

Overburden covers an area of 25 acres and looks more like boulder clay than gravel.

The gravel deposit occupies part of the northwestern slope of a boulder clay hill. It covers an area of 19 acres. According to owner, the thickness of gravel at the bottom of the pit is 12 feet, with boulder clay underneath. Farther up the slope the deposit is probably much more bouldery and a very large number of boulders are seen on surface between the eastern edge of the deposit and the road.

Very small ridge; no gravel seen on surface, because of the thick overburden. Amount available uncertain. Looks very small.

Good drainage. Gravel sells 25 cents a load. Overburden: 8 to 12 inches. Gravelly soil, sandy loam. Hauling distance of 4 miles to the front road, canal and railway siding.

Gravel sold 25 cents a load. Overburden: 8 to 12 inches. Gravelly soil, sandy loam. Hauling distance of 4 miles to the front road, canal and railway siding.

Cornwall Township—(Continued)

Map No.	Location.	Owner and Address.	Amount Excavated (in cu. yds.)	Uses.	Amount Available.	Remarks.
46	Cos. VI, lots 30, 31	U. J. McQuillan, Harrison, R.R.I.	4,000	Mostly used on roads by town- ship council. The side road nearby has been travelled on a long distance. It is in unsat- isfactory condition except where recently gravelled, the material is all loose. rolling done.	Good drainage. Gravel sold 25 cents a load. Overburden: 12 inches. Gravely loam. Stratified sand seen in the soil; part of south bank and bottom of pit, 8 feet from top of bank. Hauling distance of 3 miles to the front road sand canal, and 1 miles to a railway siding.	
47	Cos. V, lot 30	Jay Moon, Millie Rochon, P.O.	...	Small knoll on top of a boulder hill. Greatest height above boulder hill 3½ acres. Sloping, the whole knoll gravelly, there would be 5,000 cubic yards available.	Good drainage. The deposit is entirely covered with brush. Hauling dis- tance of 2½ miles to front road, canal and railway siding.	
48	Cos. VI, lots 30, 31, 32	Edgar Pyter, Moiliastte, P.O.	18	Small part of side road near by (500' east south of corner) recently gravelled. Gravel all stones too fine and too much sand. Not rolled.	Good drainage. Overburden at pit: a few inches of sandy loam. Grows thicker to ward west. Fine gravel sells 50 cents a load. Hauling distance of three miles to front road, canal and railway siding.	
49	Cos. V, VI, lots 33, 34, 35, 36	Geo. Looey, Harrison, R. I. Appel	6,000	The greatest part has been used on roads many years ago; the one road to the east has been travelled with the gravel. It is in fairly good condition in dry weather. When wet, low spots are very muddy because of bad drainage. Used by owner 7 years ago to make a concrete cir- cumference. Proportion: 1 cement, 7 gravel. Good condition.	Good drainage. Gravel sells 10 cents a load. Overburden: 2 to 6 inches of loam. About 100 cubic yards of boulders (over 5 inch.) piled in sit and around pit. Very few boul- ders over 18 inches in size. Largely treated limestone. Same hauls as for No. 50.	

50	Con. V, VI, lots 33, 34, 35, 36	William J. Murphy, Harrison R.R.I.	8.125	Used on all roads around lot. The whole of the deposit Overburden: 9 to 24 inches covers an area of 250 acres and lies in the form of ridges, boulders. Drainage good. Gravel soils 15 cents a load run of the bank and 25 cents in the back. Test pits dug two years ago by the Grand Trunk Company. Three test pits dug along the crest of the ridge between the piles 50 and 51, one said to have been 12 (30) feet deep. Very boundary gravel found all through. Another test pit dug 200 yards north of brick house north of road. Fairly coarse gravel found, with boulder clay at depth of 12 feet. Hauling distance of 4 miles to front road, canal, and railway siding.
51	Con. V, VI, lots 33, 34, 35, 36	Geo. C. Winters, Woodinette, R.R.	113	Gravel from pit 51 was used in same deposit as for No. 50 in 1917 on road from school going west as far as township limits. The subsoil is soft clayey loam and much swampy. The gravel was not rolled. It is all loose, with ruts 2 to 3 inch deep in wheel tracks. Used by neighbour for concrete.
52	Con. II, lot 2	J. G. Adams, Wales, R.R.I.	9.462	Largely used to repair roads. Rounded ridge with a general Overburden: 9 to 6 inches. In 1913, 3,000 yards crushed east-west direction and cut in pit and used to stone parts of old road nearby and side road to Ilesenburg. Fair condition after being sufficiently rolled by traffic. Owner received 25 cents per yard. A little used for concrete.

Osnabrück Township.

Osnabuck Township—(Continued).

Map No.	Location.	Owners and Addressee.	Amount Excavated (in cu. Yds.)	Used.	Amount Available.	Remarks.
53	Con. I, lot 2.....	James Anderson, Dickinson's Lading P.O.	130,000	Used many years ago by the Grand Trunk Company for railroad ballast. Recently used on short pieces of front road. Gravel all loose; large proportion of sand.		The deposit forms a wide ridge running in a north-south direction, covering an area of 40 acres. The east and south parts are largely boulder sand. Boulder clay over 20 feet in depth from top of ridge.
54	Con. I, lot 14.....	James Miller, Wales, R.R.	18,632	Largest part used by the Grand Trunk Company in 1907 for ballast. Used for concrete, such as sidewalks, in Farmer's Point and Dickinson's Landing, Farmer's Point. Used for repairing front road, west of pit. Poor condition in 1917.		Small rounded ridge running approximately north-south and covering an area of 8 acres. Boulder clay found in pit at depth of 6 feet from top of bank, but this is the greatest depth, and the deposit is apparently nearly exhausted.
55	Con. I, lot 15.....	James Miller, Wales, R.R.	None.....			Small rounded ridge running approximately north-south and occupying an area of 7 acres. Similar ridge to No. 54, and almost available, looks about the same.
56	Con. III, lot 13.....	Frank Smith, Lanesburg P.O.	5,105	Greatest part used to repair roads in con. III and IV. Three years ago a crusher was installed in pit and 2,000 cubic yards of crushed boulders used to stone side road nearby. Rather poor condition in 1917. Used for concrete sidewalks, foundations, stable floors, etc., in and around Lanesburg.		The deposit forms a sharp ridge along the west edge of a boulder clay and sand hill. Good drainage. Overburden 1 to 2 feet. Gravelly lean gravel soil 25 cents a load. Much of the gravel would need to be screened. Hauling distance of 4 miles to the front road.
57	Con. IV, lot 11.....	Edgar S. Shaver, Wales, R.R.	1,400	Largely used on roads. The sharp ridge along the west edge of a boulder clay hill, between con. III and IV, was gravelled several years ago. Satisfactory, but many large stones exposed.		Good drainage. Gravel sells 20 cents a load. Overburden 3 to 6 inches of lean gravel to a depth of 15 feet in pit. Underneath the crest of the ridge 12 feet.

58	Con. IV, lot 15.....	Preston, Rombough, Wales, R.R. 2	95	Unknown.....	95	Unknown.....	The deposit forms a flat ridge Good drainage. Overburden: 3 to 4 inches. Sandy loam. Gravelly loam, with many boulders. Hauling distance of 41 miles to the front road.
59	Con. IV, lots 17, 18	Hermann Alguire, Osnabruck Centre P.O.	400	Used to gravel roads many years ago, before present owners had the property.	400	Used to gravel roads many years ago, before present owners had the property.	The deposit covers an area of 39 acres, and rises only a few feet above the flat. The highest point being at pit No. 50, where a sharp sloped ridge runs in a north and south direction, its crest being 4 yards above the flat. Along east and south edge, boulder clay is probably close to surface.
60	Con. IV, lots 17, 18	Siles Cook, Osnabruck Centre P.O.	17	Unknown.....	17	Unknown.....	Same deposit as for No. 50.
61	Con. IV, lots 24, 25, 26, 27	Zack Hart, Porcupine.....	48	Unknown.....	48	Unknown.....	Same deposit as for No. 63.....
62	Con. IV, lot 24, 25, 26, 27	Zack Hart, Porcupine.....	7,028	Used for 8 years. by people around for repair- ing roads. All gravel used for roads for the last 8 years was taken from pit No. 63	7,028	Used for 8 years. by people around for repair- ing roads. All gravel used for roads for the last 8 years was taken from pit No. 63	Good drainage. Overburden: 6 inches. Gravelly sand and sand, with thin layers of loam on top. Same haul as for No. 50. See No. 63.
63	Con. IV, lots 24, 25, 26, 27	Osnabruck Township Council North part owned by W. N. Hollister, Farran's Point, R. R. 1.	14,731	The largest part of gravel was used for roads. The road south of pit, from lot 25 to lot 30, was staked with crushed gravel in 1916. No rolling done. In 1917, it was in fairly good condition, but apparently is wearing out rapidly.	14,731	The deposit extends over an area of 145 acres; it forms two ridges, one at pits 61 and 62, the other one at pit 63, but the rest of the deposit rises only a few feet above boulder clay. At house, northeast end of de- posit, depth of gravel 7 feet from well records, at pit 62, boulder clay found 9 feet below top of ridge, and at pit 63, 20 feet below top of the other ridge. Very little gra- vel seen along south edge of deposit, and boulder clay is probably very close to sur- face.	Good drainage. Overburden: 8 to 12 inches. Loam and sand. Gravel needs to be screened. Same haul as for No. 63.

Osnabuck Township—(Continued).

Map No.	Location.	Owners and Addressee.	Amount Excavated (in cu. yds.)	Uses.	Amount Available.	Remarks.
64	Con. III, lot 32.	Chas. F. Dafoe, Autsville, R. R. 1.	50	Unknown.	Very small ridge, 1 yd. above the flat. Amount available apparently very small.	Good drainage. (Overburden: 12 to 15 inches of sandy loam. Gravel sells 50 cents a load in the bank, and 30 cts. in the pit. Hauling distance of 4 miles to front road and 3½ miles to railway siding.
65	Con. III, lot 32.	Wm. T. Dafoe, Autsville, R. I.	1,527	The greatest part of the gravel (overburden included) was used to repair the road nearby. Too high proportion of sand. Very poor condition. No rolling.	Very small ridge, 5 inches in extent along the west side of a boulder clay deposit. Boulder clay found in pit at depth of 4 feet below the top of the ridge. Small amount.	Good drainage. (Overburden: 12 to 15 inches of sandy loam. Gravel sells 50 cents a load in the bank, and 30 cts. in the pit. Hauling distance of 4 miles to front road and 3½ miles to railway siding.
66	Con. III, lot 32..	Wm. T. Dafoe, Autsville, R. I.	1,500	Used 5 to 8 years ago on roads. Side road went west of deposit in con. II, gravelled in places, stoned in others. Good condition, much better where stoned than where gravelled. Stoned in 1915.	Same deposit as for No. 65.	Boulder clay 4 feet from top of ridge.
67	Con. II, lot 33..		15	Unknown.	Very flat deposit and amount available apparently very small.	Overburden, 12 inches. Gravelly and sandy loam. Drainage good.
68	Con. I, lot 31..	Willie Densoe, Autsville.	400	Used to repair front road. Concrete sidewalks in Autsville.	Very small layer of gravel on top of boulder clay. Thickness varies from 1½ to 5 feet, including overburden. Very small amount available.	Drainage good. Overburden: 1½ to 2 feet. Gravel sells 15 cents a load for roads, and 25 cents for concrete.
69	Con. III, lot 1.....	George Williams, Williamsburg, R. R. 1.	3,302	Said to have been used largely on the concession road nearby. Road in very poor shape. All stoned, except at the pit. The sub-soil of the road is a soft loam with muck in places.	Flat ridge covering an area of 12 acres. The west end is now exhausted. Boulder clay seen in pit, 1½ feet below top of ridge. In the east end surface indications show very little gravel, and the amount now available is very small.	Overburden: 14 inches. Gravel sells 25 cts. a load. Hauling distance of 4½ miles to the front road.

Williamsburg Township.

70	Con. III, lot 3.....	Thomas Marion, Williamsburg P.O.	30	To be used for concrete.....	Apparently a pocket of gravelly sand.
71	Con. II, lot 4....	Rubin Prusser, Aultsville, R. R. 1.	620	Used for concrete. In 1916 owner built a stable floor and eastern in concrete. Proprietary. 1 concrete, 5 gravel. Very good condition in 1917.	In 1916 thin layer of gravel on top of boulder clay; greatest thickness 3 feet. Of no value for future development.
72	Con. II, lot 5 ..	W. K. Farmer, Morrisburg P.O.	2,260	Said to have been all used on roads many years ago.	Bad drainage. Difficult to drain. Gravel wells 30 etc. a load. Overburden, 8 to 15 inches. Loam, sandy loam. Hauling distance of 2½ miles to the front road.
73	Con. IV, lots 14, 15 .	Malcolm Beckstead, Williamsburg, R. R. 2.	5,700	No gravel used for twenty years. The side road north of Morrisburg was gravelled long ago with gravel from the deposit. Broken stones put on surface.	(Drainage good. Hauling distance of 4½ miles to front road.)
74	Con. III, lot 27.....		44	Unknown.	Narrow ridge covering an area of 10 acres; height above the flat; north end 3 feet; south end 10 feet. Depth at south end 10 feet. The best part of the deposit, the south end, is nearly all worked out. From indications there would be a large proportion of boulders easy or sand in the north end.
63	Con. I, lot 1.....	H. W. Doran, Morrisburg	3,382	For repairing roads in vicinity and for concrete works in Morrisburg.	The deposit occupies part of the west slope of a boulder hill. Height 2 yrs. Apparently very small amount of material.
84	Con. I, lot 3.....	George Larmer, Morrisburg	32	Used locally for concrete	Same deposit as for No. 33.

Matilda Township.

62	Con. II, lot 1.....	John C. Johnson, Matilda	1,000	Overburden: top of 1 foot of bouldery loam. Drainage good. Gravel wells 20 etc. a load. Loams more like boulder sand. Bottom of pit covered with boulders. Hauling distance of 1½ miles to the front road and canal.
63	Con. I, lot 1.....	H. W. Doran, Morrisburg	3,382	Narrow ridge having a general northwest and northeast direction, and occupying an area of 20 acres. Boulder clay found at several places at depth of 6 feet below the crest of the ridge.

Matilda Township—(Continued).

Map No.	Location.	Owners and Addresses.	Amount Excavated (in cu. yds.)	U. S. S.	Amount Available.	Remarks.
85 Con I, lot 3.	Albert Beckstrand, Morrisburg		2,420	Used locally for concrete; for same deposit as for No. 83... near at Morrisburg.		Overburden: 1 to 1½ feet of loam. Draught good. Gravel with 50 etc., a load. Pit within one mile of the front road and canal.
86 Con. III, lot 5.	William Mallin, Iroquois, R.R. 1.		3,000	Used in July, 1917, on concession road north, as far as the east end of statitis tow-shed. Gravel dampened on the road, without rolling. Very bad condition. Underlying soil: loam and muck (swamp). Rate all along. Much muddy mud on surface. Weather-rainy. Was used a long time ago on the side road between lots 17, 18 and 19, con. II and III, which has since been washed with Brocks stone.	Small ridge, 4 acres in area, showing west edge of boulders clay deposit. The ridge is 4 yards in height at the south end and 2 yards at the north end. At pit in north of the pot there is a pile containing about 400 cu. yds. of boulders (from 5 to 24 inches in size). Gravel is poor on account of its coarse sand and gravel, which is weathering. It should be crushed to be used on roads. This ridge is part of the divide between the N. Lawrence and Ottawa valleys. Head of 3½ miles to front road and canal, through 1½ miles of bed roads, in rainy weather.	Bad drainage. Could be easily drained by proper ditching.
87 Con. II, lot 19.	Edgar Shaver, Iroquois R.R. 2.		807	Used for concrete embankment, covering an area of 4 acres. Gravel and sand. Between pits Nos. 87 and 88 there is a layer of sand which increases the overburden to over 2 yards. Draught good. Gravel with 50 etc., a load. for roads and 75% for concrete. The deposit is on the divide between the N. Lawrence and Ottawa valleys. Heating distance of 3 miles to the front road.	Small ridge, covering an area of 4 acres. Gravel and sand. At depth of 6 feet in pit 88 there is a layer of sand which increases the overburden to over 2 yards. Draught good. Gravel with 50 etc., a load. for roads and 75% for concrete. The deposit is on the divide between the N. Lawrence and Ottawa valleys. Heating distance of 3 miles to the front road.	Used for concrete in Iroquois. Some deposit as for No. 87.
88 Con. II, lot 20.	James Brouse, Iroquois, R.R. 2		7,368	Used for concrete in Iroquois. Same deposit as for No. 87. Some remarks as for No. 87. Same remarks as for No. 87. Not so much gravel sold now.		

89 Con. I, lot 21.....J. H. Birnes, Troxoco.

90 To repair front road.
used for a few years.

Small ridge, 2½ acres in extent. Good drainage. Overburden 1 foot of loam, with coarse sand. No gravel used for a few years. Deposit within 250 yards of the front road and canal.

90 Con. I, lots 32, 33.....Jay. Matley, Troxoco, R.R. 2

Used by owner 4 years ago to make a concrete stable floor. Proportion: 1 cement, 9 gravel. Good condition. Never used as roads.

The mapped deposit forms a small flat ridge, 10 acres in area. It runs parallel to the shore of the river nearly, and lies on the southeastern slope of a boulder ridge. In pit, sandstone and of deposit, broken clay as found 12 feet below the crest of the ridge. However, that portion was mapped which showed gravel and sandstone. Deposit within 250 yards of the main road and canal.

Edwardsburg Township.

91 Con. II, lots 2, 3.....George Stethem, Cardinal, R.R. 2.

Used locally for concrete...

The deposit occupies an area of Overburden: 2 feet of loam 3 acres on part of the west slope of a boulder ridge. A 25 ft. test pit dug by the Gravel and 25 feet of gravel, sand, and probably some loam. More like boulder sand.

92 Con. II, lots 4, 5.....Rufus Froom, Cardinal, R.R. 2.

Flat rounded ridge, covering Overburden: 11 to 12 feet sandy loam. West face of ridge good. Gravel well distributed. 2 feet of loam on top of sandy clay. Gravel and 25 feet of Test pit dug by G. T. Co. a few years ago, and it is said that gravel was found all over the ridge. Probably much boulder clay or sand in the east slope, resulting from similar deposits from a further west. Has some distance of 1½ miles to the front road and canal.

90 Con. I, lot 21.....J. H. Birnes, Troxoco.

90 To repair front road.
used for a few years.

Small ridge, 2½ acres in extent. Good drainage. Overburden 1 foot of loam, with coarse sand. No gravel used for a few years. Deposit within 250 yards of the front road and canal.

The mapped deposit forms a small flat ridge, 10 acres in area. It runs parallel to the shore of the river nearly, and lies on the southeastern slope of a boulder ridge. In pit, sandstone and of deposit, broken clay as found 12 feet below the crest of the ridge. However, that portion was mapped which showed gravel and sandstone. Deposit within 250 yards of the main road and canal.

65

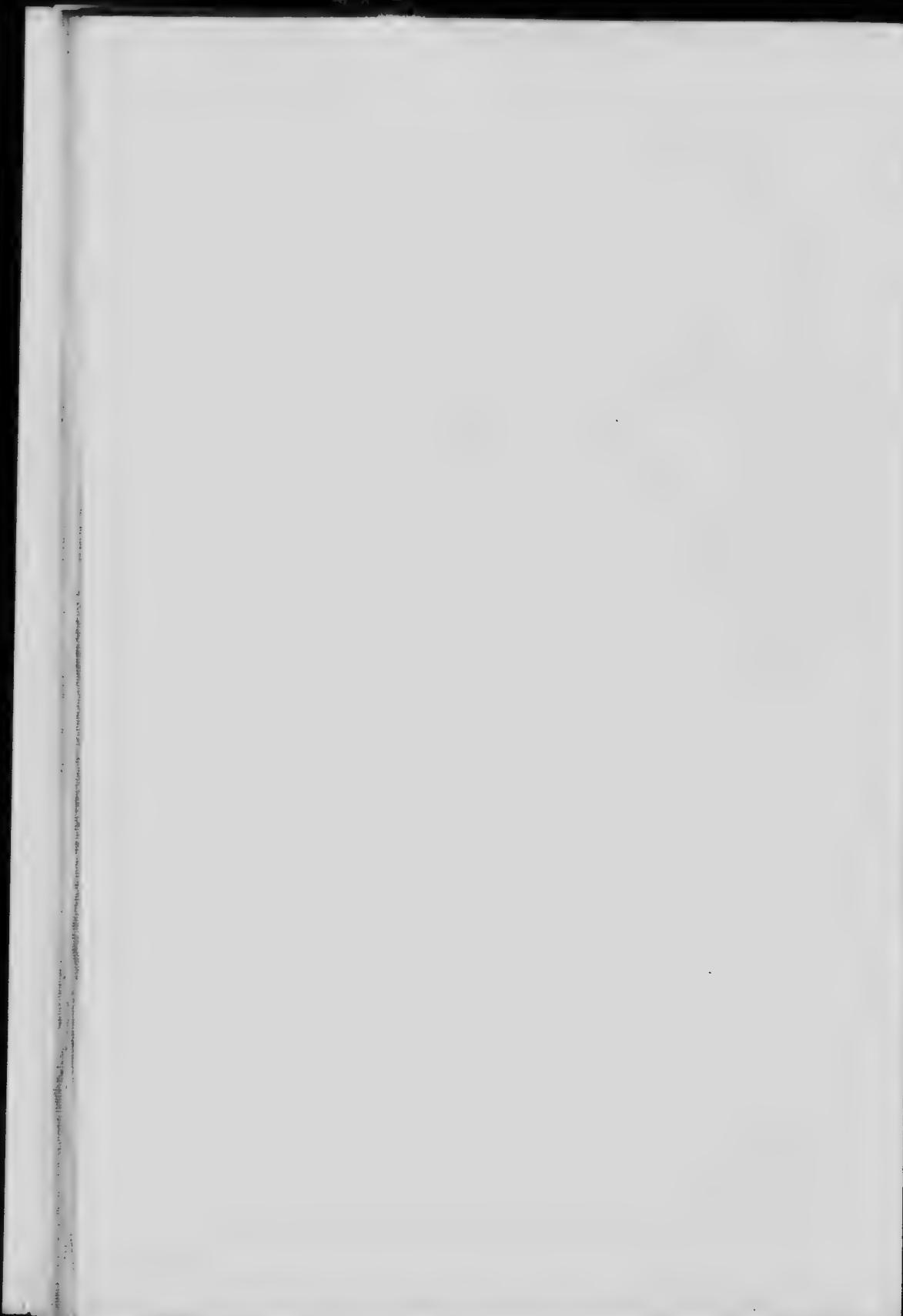


PLATE I.



Long Sault rapids and Cornwall canal, St. Lawrence river, west of Long Sault.

PLATE II.



Pit No. 50 (Murphy's). The gravel turns more bouldery and less markedly stratified towards the top of the deposit (left of picture).

77468

PLATE III.



Pit No. 56 (Smith's). Showing bouldery gravel in the upper part, and becoming finer towards the bottom.

PLATE IV.



Pit No. 63 (Hollister's). Showing section of very bouldery gravel directly underneath the top of the ridge.

PLATE V.

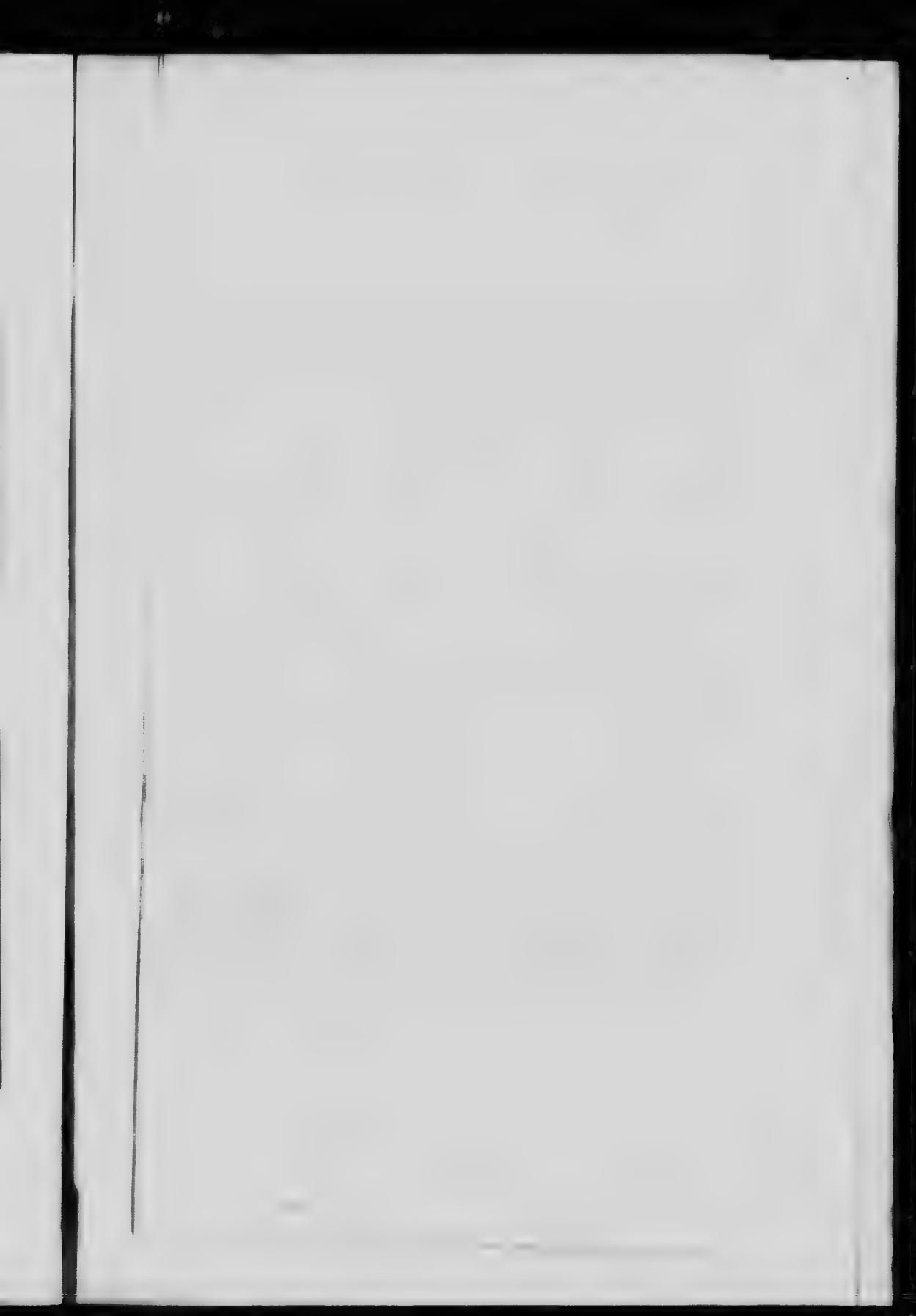


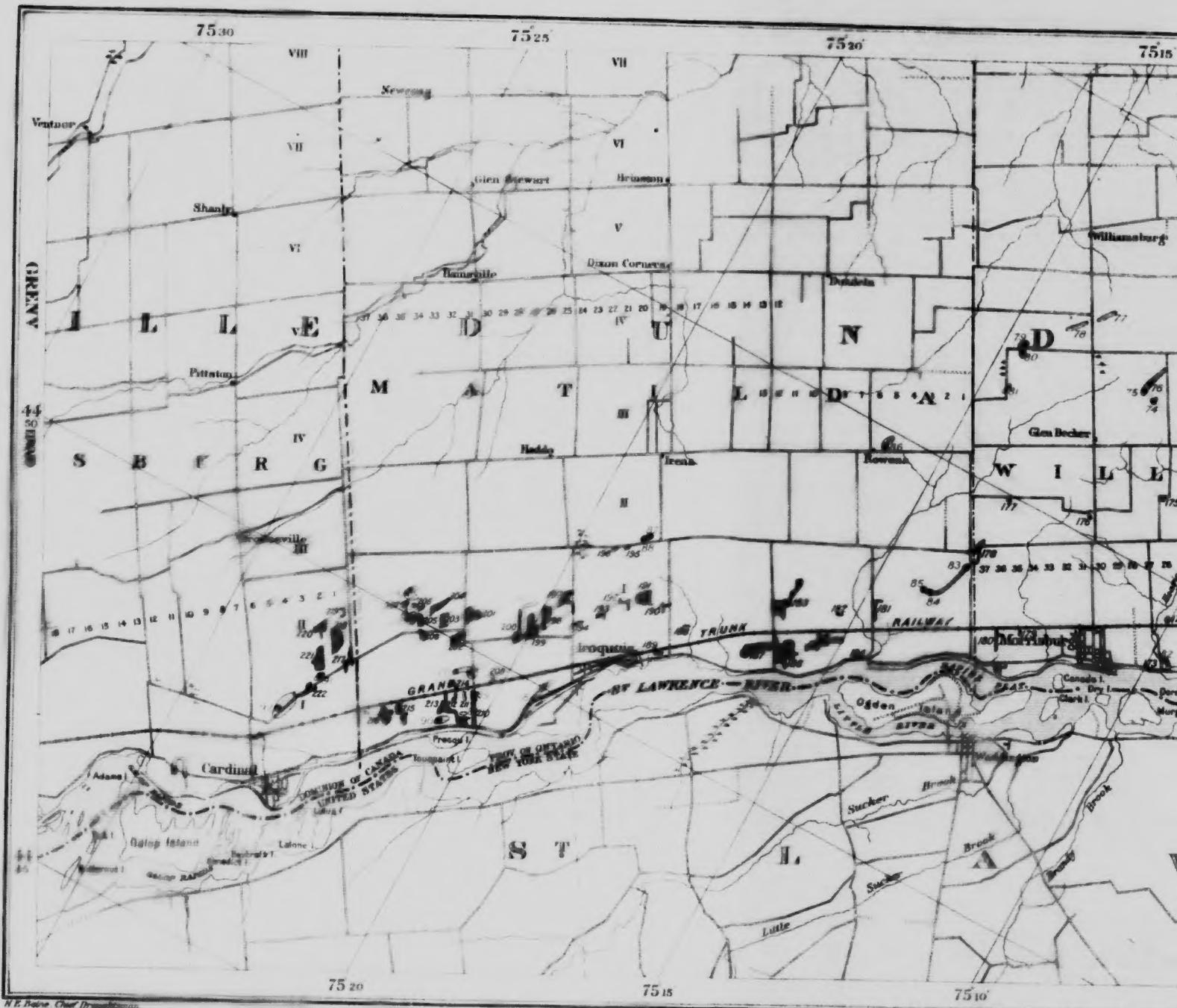
Pit No. 92 (Froom's). Illustrating stratification. Boulder sand seen at the extreme left of the picture.

PLATE VI.



Adam's Quarry, in rock outcrop No. 25. The upper part of the wall in centre of picture shows intensely weathered rock.





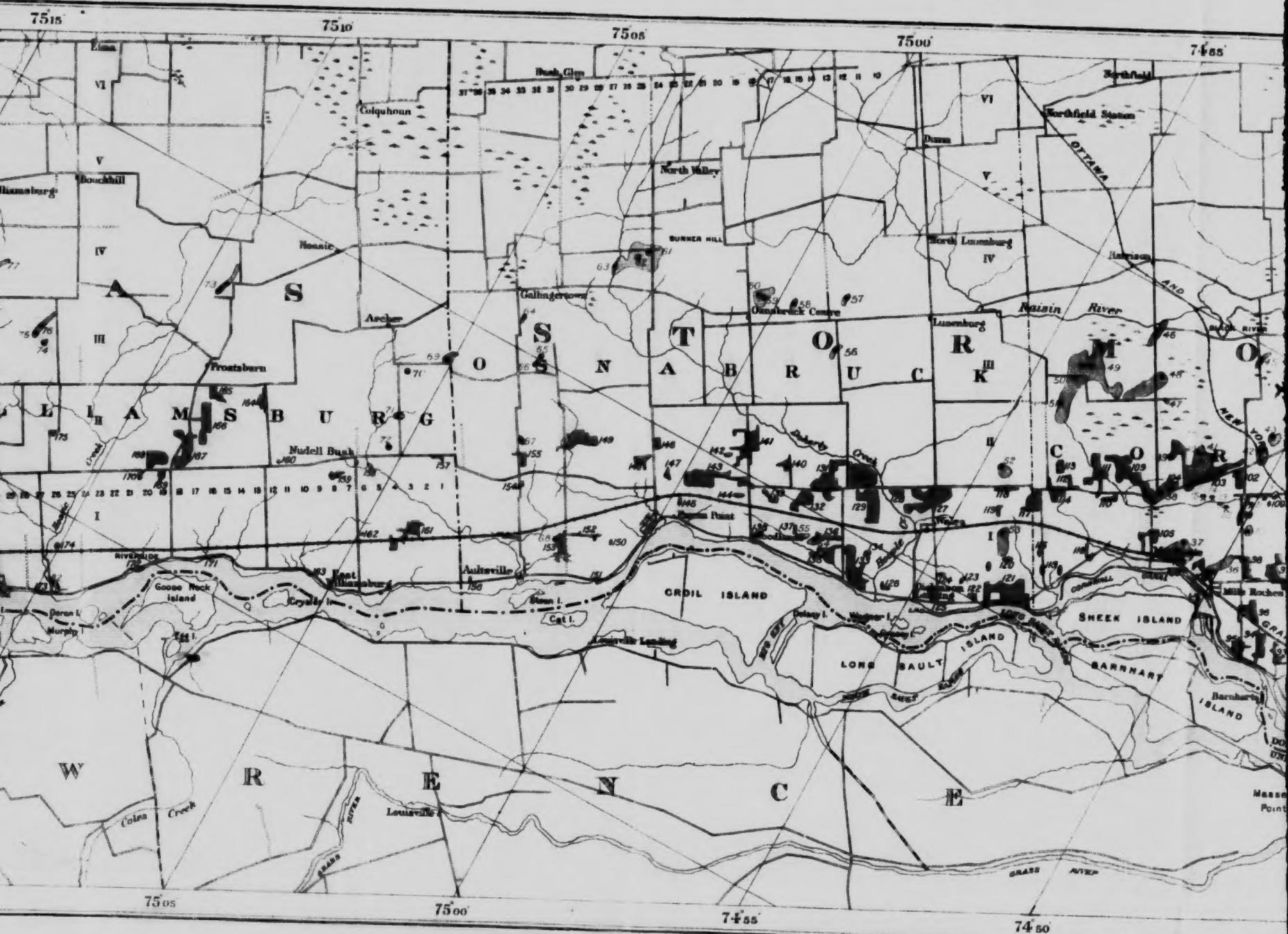
N.E. Bain, Chief Draughtsman
Westwood, Drawings Office

Outline map
Department of Militia and Defence

CANADA
DEPARTMENT OF MINES
MINES BRANCH

HON ARTHUR MEIGHAN, MINISTER, R G MC CONNELL, DEPUTY MINISTER
EUGENE HAANEL, PH D. DIRECTOR

1920



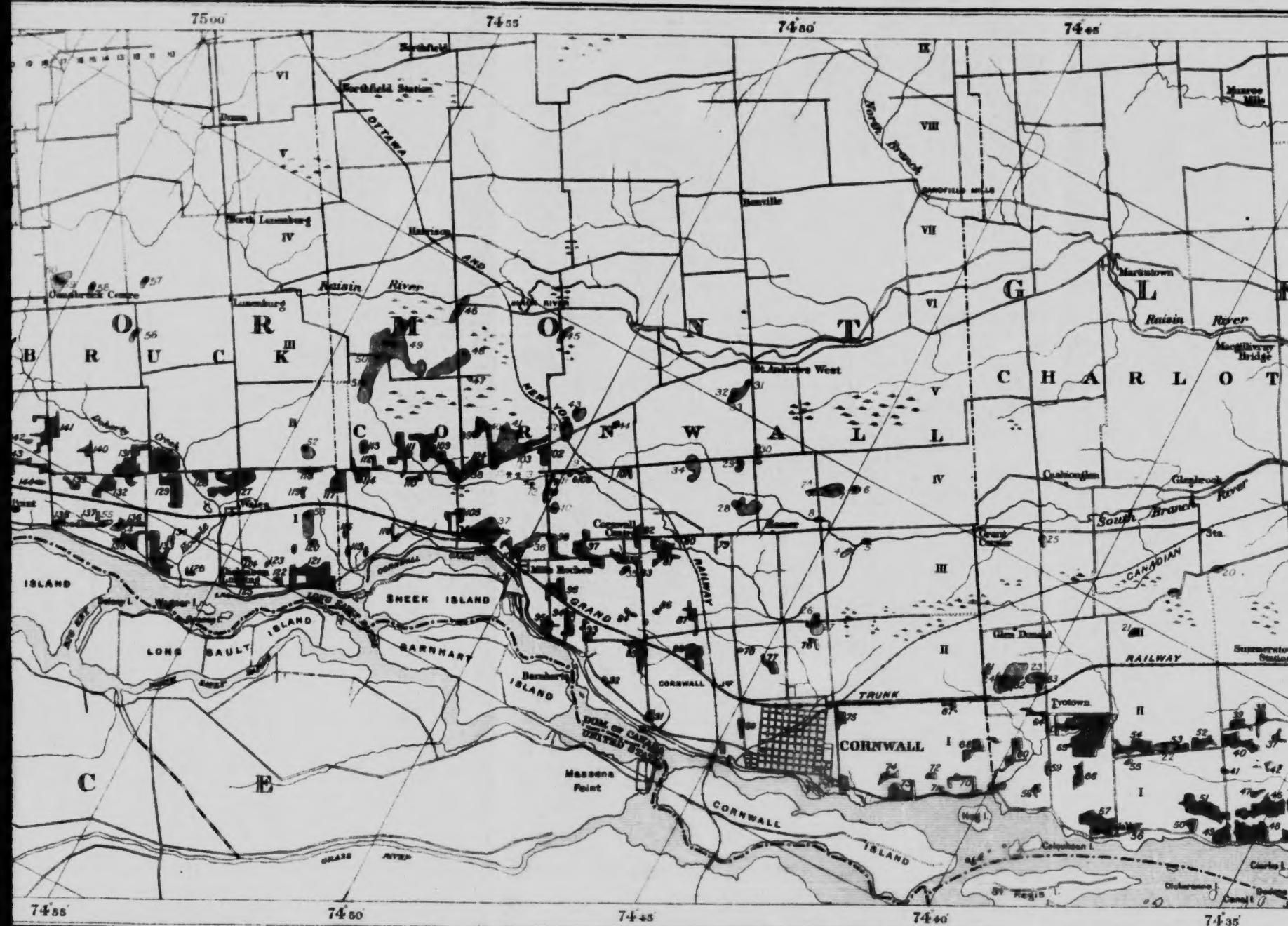
DEPOSITS OF STONE AND GRAVEL AVAILABLE FOR HIGHWAY
BETWEEN CARDINAL AND THE QUEBEC BOUNDARY

Scale of Miles
1 2 3 4 5

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IRON AND GRAVEL AVAILABLE FOR HIGHWAY CONSTRUCTION
CARDINAL AND THE QUEBEC BOUNDARY

Survey of materials
by R.H. Picher

Scale of Miles



